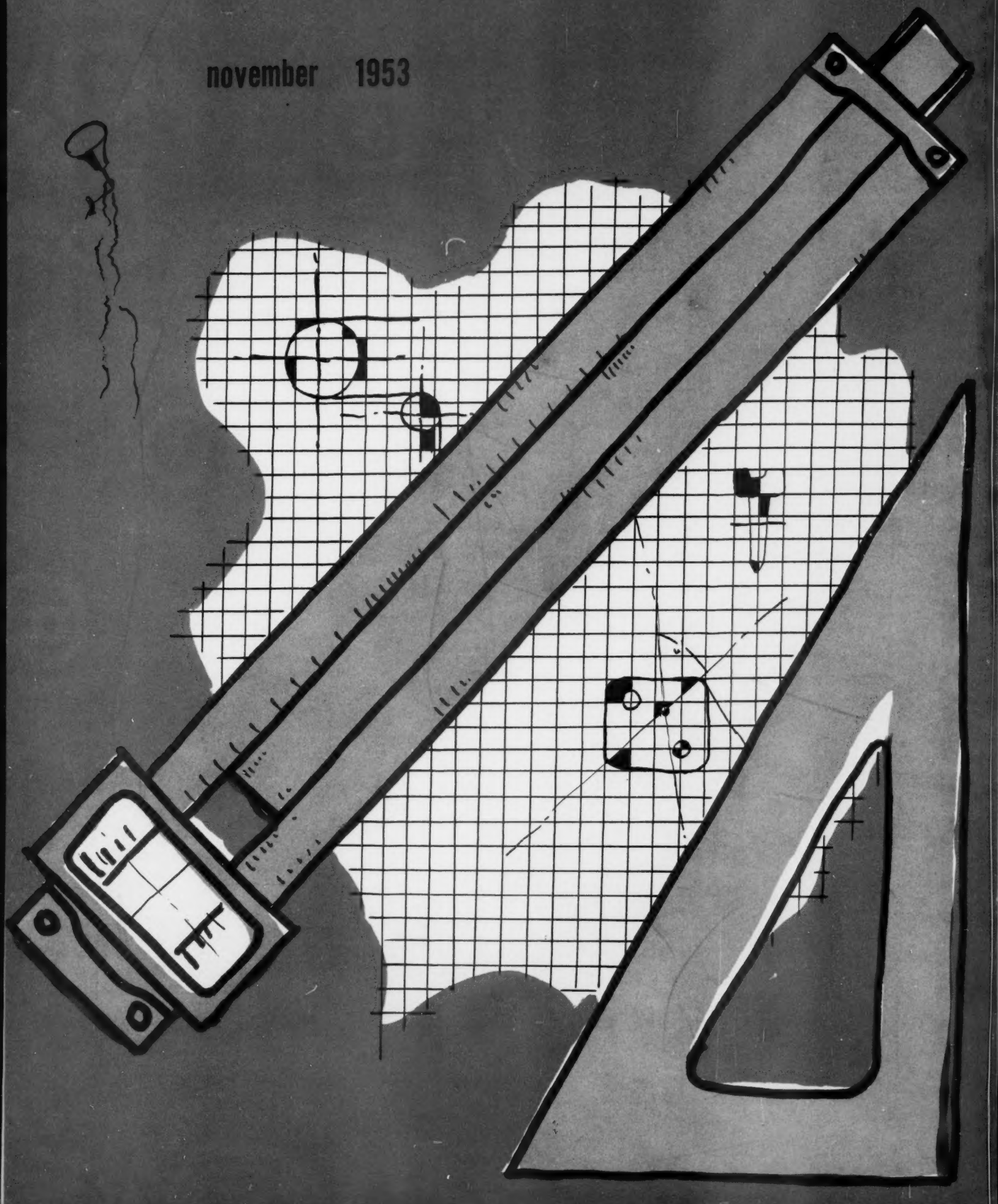
tech engineering news

november 1953



Reductio ad optimum

U·S·S CARILLOY electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment it gets at Cleveland Pneumatic Tool Company complete the job.

● "Reduced to the most favorable degree" describes exactly what happens to the huge U·S·S CARILLOY steel ingots from which are formed the rugged main columns in the landing gears of *every* B-36.

To provide the tremendous strength and shock resistance required to safely cushion the landing impact of 179 tons of bomber weight—and, at the same time, to keep the weight of the landing gear as *low* as possible—calls not only for steel of the highest quality but also for unusual procedures in fabrication as well.

Consider these facts. The original ingot weighs approximately 37,500 lbs. From it are produced two cylindrical columns weighing only about 1200 lbs. apiece. Approximately 93% of the steel is removed by machining to proper contour and in hollow-boring the column. When finished, a mere 7% of the original ingot is left to do the job.

That U·S·S CARILLOY steel has been exclusively selected for this application—one of the most exacting in the aircraft industry—is, we believe, highly significant. The same care and skill, the same ability to meet requirements that are beyond the ordinary, go into every order of CARILLOY steel we make—whether it's an ingot of giant size or a few tons of special steel.

U·S·S CARILLOY is just one more example of the better steel products developed and produced by United States Steel. If you are interested in additional engineering training, why not investigate *your* opportunities with U. S. Steel? For more information, contact the Placement Director of your school, or write to United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

USS

UNITED STATES STEEL

Where do profits go?

To increase your standard of living

OUT OF EVERY DOLLAR YOU SPEND, less than 5¢ can be kept as profit by the average company supplying you. A good part of that 5¢ is then used to buy new machines. (Only 2¢ ever reaches the owners as dividends.)

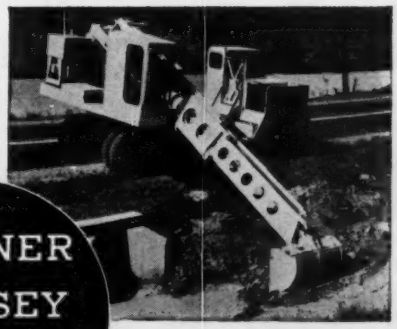
These new machines produce more, at lower cost. To stay in business in America's highly competitive system, machine owners pass on those lower costs to you in lower prices. (Remember your first mechanical refrigerator at $700, your first radio at $400?)

Stop the profits and you will stop this process of better and better values. As machines grow older, they will produce less and less and so what they produce will cost you more and more.

Remember that, next time you hear someone attack profits. He's recommending *higher prices for you.*

Statistics from:
National Association of Manufacturers;
Air Cond. & Ref. News;
Electrical Merchandising.

Warner & Swasey is a group of men who work hard, respect each other, and enjoy the satisfaction of group accomplishment. If that sort of life appeals to you, write Charles Ufford for employment opportunities here.



Gradall at work

WARNER & SWASEY
Cleveland
PRECISION MACHINERY SINCE 1880

YOU CAN PRODUCE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY MACHINE TOOLS, TEXTILE MACHINERY, CONSTRUCTION MACHINERY

The prof who put off a trip to Europe

He had his tickets. He was all set to sail.

Then this professor of engineering at one of America's leading educational institutions received an invitation to General Motors Engineering Educators Conference.

So, having heard reports on the success of the 1952 conference, he put off his trip and joined in the two-week session of meetings and field trips.

Q.E.D.—he was delighted. Said he wouldn't have missed it.

Why? Because, like his fellow educators, he found GM executives meant what they said when they told their guests:

"One of the principal objectives of this Conference is to make us better acquainted with each other's problems. We hope that you will develop personal contacts during the Conference that will assist you in the future. By developing better mutual understanding and cooperation between education and industry, together, we can do a better job of solving the engineering problems of the future and maintaining our Nation's technical leadership."

Yes, the engineering mind is bound to find a congenial intellectual climate at General Motors. For we respect the engineering point of view. As proved by the number of key GM executives in both divisional and top management who began their careers as engineering graduates on GM drafting boards.

So to you faculty members we say: please feel free to write us or ask our College Representative, who periodically visits your campus, any questions, however detailed, on the subject of GM jobs for your talented students.

And to you soon-to-graduate engineers, we say, better think seriously about a GM future. It's yours, if you have what it takes.

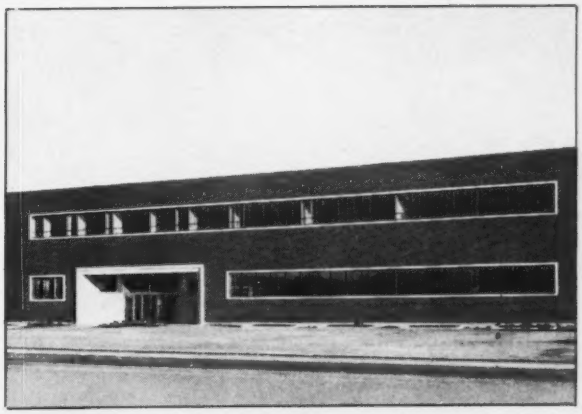
GENERAL MOTORS CORPORATION
Personnel Staff, Detroit 2, Michigan

DOW

NEW DOW

Technical Library

ENABLES EMPLOYEES TO FURTHER STUDIES



These modern facilities provide an extremely wide range of scientific material including current information on all fields of research

The desire to provide complete technical knowledge for Dow personnel, together with intelligent planning, has produced at Midland, Michigan, one of the most comprehensive of all industrial libraries. This modern, air-conditioned structure contains over 35,000 books and over 600 magazines. New books are added regularly, and both foreign and domestic abstracts are made available.

Most of the material is highly technical. The most extensive coverage is given to material in the fields of chemistry, electrochemistry, biochemistry, agricultural chemistry, chemical engineering, physics and nuclear physics.

In addition to published material, the library also furnishes an index of all research work conducted by all divisions of The Dow Chemical Company.

This new library is but one example of Dow's efforts to offer the finest facilities for work and recreation to its employees. THE DOW CHEMICAL COMPANY, Midland, Michigan.

Dow's Booklet "Opportunities With The Dow Chemical Company", especially written for those about to enter the chemical profession, is available free, upon request. Write to The Dow Chemical Company, Technical Employment, Midland, Michigan.

you can depend on DOW CHEMICALS

DOW

tech engineering news

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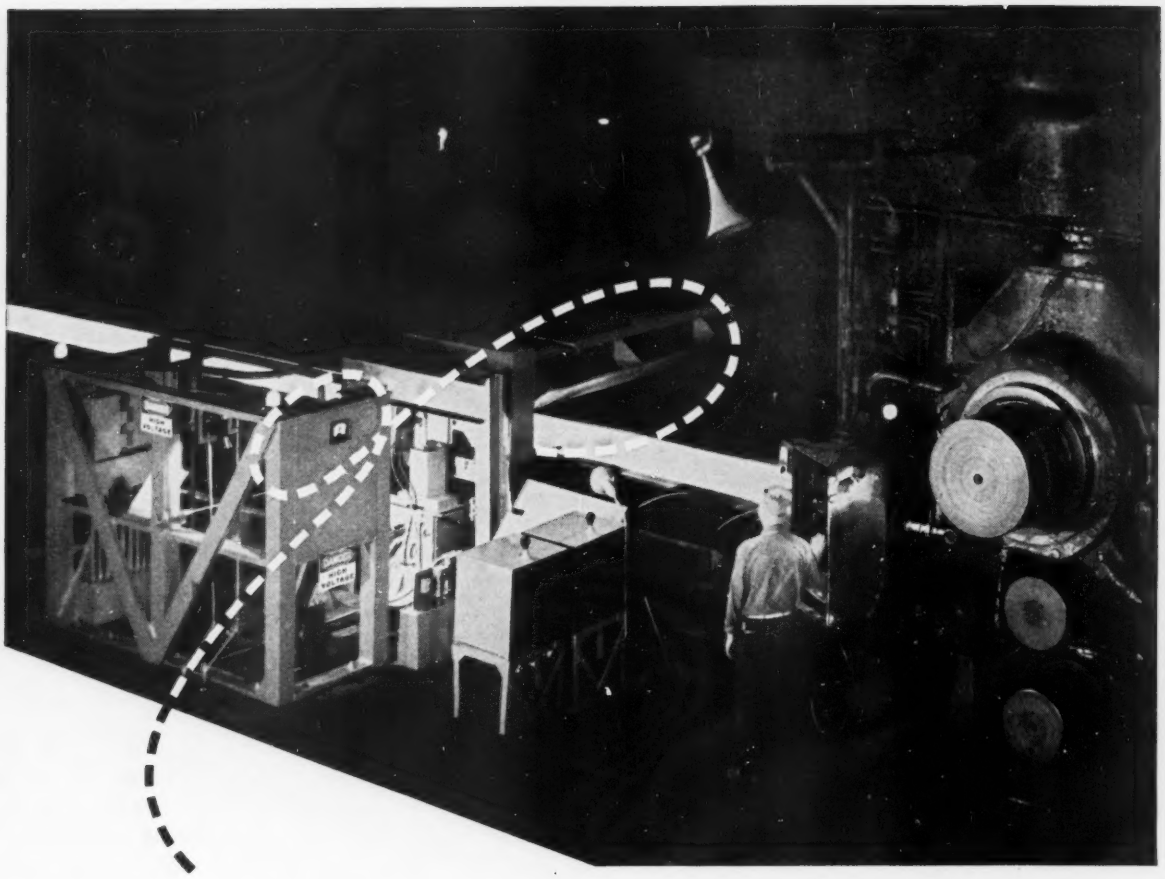
FRONTISPIECE

Torches of Learning

Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Massachusetts under the Act of March 3, 1879. Copyright 1953 by The Tech Engineering News. Subscription per year $1.75. Foreign $2.50. One copy 25 cents.



HITCH YOUR CAREER TO A PLACE WITH NEW METHODS

Under that white-hot strip of steel is an X-ray tube. Close above the steel is a specially-designed electronic measuring device.

As the steel strip speeds by at half a mile a minute, a ray beamed up through the steel is automatically measured. The results on a dial before the eyes of the "roller" give him a continuously accurate check on the thickness of the flat-rolled steel down to thousandths of an inch.

Thus, Republic employs modern science to make possible better thickness control of steel sheets and strip.

Perhaps, if you've never worked for a steel manufacturer, or sold a basic material, the import of an X-ray measurement may not raise you to high emotion. But customers know it saves them money because it avoids a lot of reject material. They have more confidence in X-ray-measured steel. They tend to favor the Republic man.

When you become part of an organization, you'll want your company backing you up with new ideas—not just standing behind you.

REPUBLIC STEEL

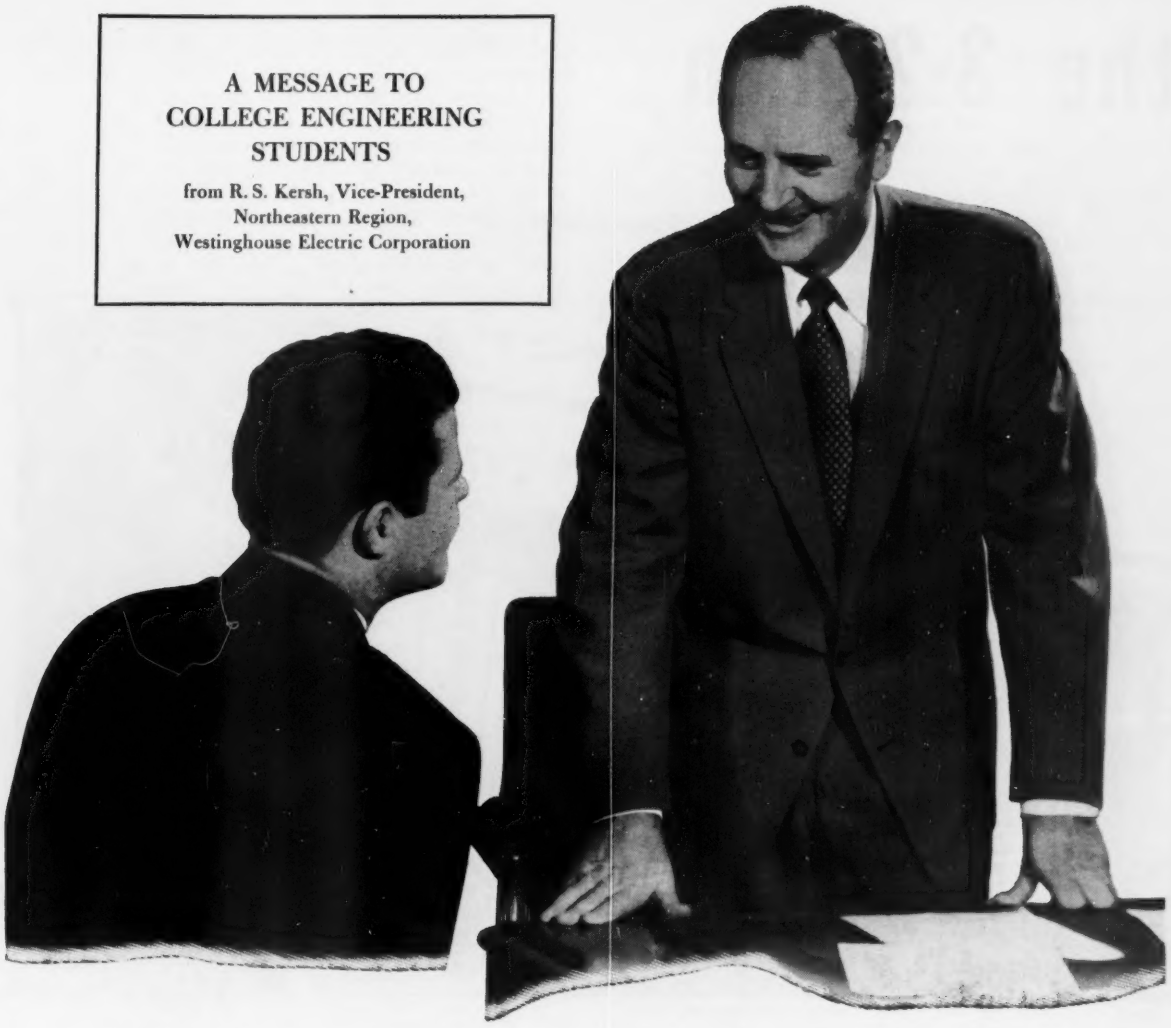
GENERAL OFFICES . . . CLEVELAND 1, OHIO

REPUBLIC STEEL

WORLD'S WIDEST RANGE OF STEELS AND STEEL PRODUCTS

A MESSAGE TO COLLEGE ENGINEERING STUDENTS

from R. S. Kersh, Vice-President, Northeastern Region, Westinghouse Electric Corporation



To the young engineer eager for a sales career

Show me an engineer with a friendly attitude, and an eagerness to help people solve their problems and I'll show you a good sales engineer.

There's nothing mysterious about this job of being a sales engineer. To apply the products of his company to his customers' needs, he must be a good engineer.

To gain the confidence of his customers he must be a good salesman. This means simply that he should have an inquisitive nature, the desire to help others, and the quality of enthusiasm.

The Westinghouse sales engineer works with our design engineers, production engineers and engineering departments of our customers. He is a highly important and valued professional man.

What are the opportunities at Westinghouse for a young man eager for a career in sales? They are just about what you want to make them! This company's 30 divisions make over 3,000 products, totaling over $1½ billion in sales annually. Westinghouse is looking to the future with a vast expansion program. We are a fast-growing company in the dynamic field of electrical energy.

If your sights are set on a sales career, I am sure you will find the training and opportunity you seek with Westinghouse. G-10272

YOU CAN BE SURE... IF IT'S Westinghouse

For information on career opportunities with Westinghouse, consult Placement Officer of your University, or send for our 34-page book, *Finding Your Place in Industry.*

Write: Mr. R. E. Davis, Regional Educational Co-ordinator, Westinghouse Electric Corporation, 10 High Street, Boston 10, Massachusetts.

the 3-2 plan

by Peter Schultz, '55

A "technical" education at a school like M.I.T. has many advantages. There is the opportunity to take so-called professional courses as an undergraduate, to get a professional degree or "meal ticket" after only four years of study, to take part in many extra-curricular activities, to use many of the facilities at Tech and to meet and become acquainted with many different types of people. There are also some features that the "technical" education lacks. One is flexibility. In most engineering schools the student has to decide what course he wants to take or what field he wants to major in at the end of his freshman year. At this point many students do not know what career they want to follow. At a liberal arts college the student usually does not have to choose his "major" until the end of his sophomore year and even then he does not have to choose a definite, relatively inflexibile program such as mechanical engineering or electrical engineering.

There are many prospective engineering students who want to broaden their education by taking courses in literature, history, philosophy, languages, fine arts, and other non-technical subjects. Courses in these fields are not offered at many engineering schools. One could suggest that a young man who wants to become an engineer and wants a stronger background in humanities than is offered by most engineering schools could go to a liberal arts college for four years and then go to a technical school to study engineering. This is fine if he has the time and can raise the money, but few have the time with their draft boards constantly calling for their services. The problem of time is made even worse if the student plans to do graduate work in engineering. After four years at a liberal arts college it usually takes about two years to get an engineering degree at a technical school. If one wants to do graduate work, it is necessary to spend even more time. Not all students can afford this. Even so, a liberal education has much to offer and there are many would-be engineers who want to take advantage of it to broaden their outlook and understanding, or, as one person put it, "to be able to talk with the intellectuals."

As a possible solution to these problems, the so-called 3-2 Plan or "Combined Plan of Study with Liberal Arts Colleges" was started. Under the provisions of this program of study, the student spends three years at a liberal arts school and then transfers to M.I.T. It usually takes

about two more years at M.I.T. to finish the professional work. When this is done, the student receives two degrees, a B.A. from the liberal arts college he attended and a B.S. in engineering from M.I.T. This plan is not limited to engineering alone. One can take any of the undergraduate courses at M.I.T. under this plan. While at the liberal arts college the student takes basic courses in mathematics, chemistry and physics. Also he takes courses in such fields as philosophy, psychology, political science, history, english composition, languages, zoology, fine arts, music, literature, speech, sociology and religion. The science and mathematics courses that a prospective engineer takes cover just about the same material as the freshman and sophomore courses at M.I.T. During the two years at Tech, the student completes his professional studies. As the M.I.T. Bulletin of June 1953 says:

> The academic program at M.I.T. consists of three basic elements: (1) education in the humanities and social sciences; (2) education in basic mathematics, science and applied science; and (3) education in a professional field. A student may accomplish this in four years at M.I.T. Or, through the Combined Plan, he may receive his education in humanities and social sciences, basic mathematics, science, and in some cases applied science, at the liberal arts colleges. He receives further education in applied science and in a professional field at M.I.T. This alternative pattern offered by the Combined Plan extends his undergraduate education to only five years instead of a possible six or seven years.

In many cases, a student who comes to M.I.T. on the Combined Plan from a liberal arts college will find it necessary to go to summer school at M.I.T. in order to graduate after two years. The reason for this is that, at the liberal arts college, he may not be able to take some of the courses taken by Tech freshmen and sophomores. If he does not get credit for a course usually taken here at Tech during the freshman or sophomore years, it is normally advisable to take it during the summer.

It would seem as though all this Combined Plan amounts to is transferring to Tech after spending three years at a liberal arts college. This is true except for one thing: The student gets a degree from the liberal arts college as well as one from M.I.T. at the end of the five-year stint. The work at the liberal arts college is recognized by the award of a degree. If the student makes a straight transfer, it would not be.

Now the question of how one is admitted to the 3-2 Plan arises. A student interested in this plan first attends the participating liberal arts college of his choice. At each of these schools there is a faculty adviser for the plan and a faculty committee in charge of the plan. To get into M.I.T. under the provisions of the 3-2 Plan, a student must be recommended by this faculty committee.

This is a rough sketch of the 3-2 Plan and its purpose. Now we must consider whether the 3-2 Plan accomplishes its goal and whether it is worth the extra year. Each person who has studied engineering under the Combined Plan will have his own answer to this question. My knowledge of the 3-2 Plan is limited to what I learned while attending Oberlin College for three years under the 3-2 Plan attending M.I.T. and talking to others who have studied under the 3-2 Plan at other colleges. My answer to the above question will be based on this knowledge.

To me, the main advantage of the 3-2 Plan is the experience gained by studying at two different schools. This gives one the chance to meet people who are interested primarily in such subjects as psychology, government, medicine and literature. With liberal arts students, humanities courses are never a necessary educational nuisance that one puts up with because these courses are requirements for graduation. They are interesting subjects from which a lot can be learned. Becoming acquainted with these people and their interests is a very worth-while experience and well worth the extra year spent in college.

In answer to this one may say that humanities subjects or non-technical electives are required at most engineering schools. Among technical schools, M.I.T. is known for its well-rounded humanities program. In recent years many other engineering schools have reorganized and strengthened their humanities programs in response to the increasing demand for engineers and scientists who are able to "talk with intellectuals" and other people who have little background in technology or science. It is true that these programs help round out an engineer's education. But one would get a better background in the humanities and social sciences at a school where many of the students are most interested in these subjects, just as one gets a better background in engineering at an engineering school.

As far as one's liberal arts background is concerned, this plan has one disadvantage. This is that one's studies at the liberal arts college are ended after the end of the junior year. At some liberal arts colleges many interesting experiences and courses are reserved for the senior year. These are normally left out of the 3-2 Plan. Also, in order to prepare for M.I.T., the student has to take a fairly rigid set of courses which leaves little time for some of the extra courses he may want. These disadvantages are counterbalanced, however, by the fact that the student must attend school for five years and possibly one extra summer instead of six or more years. As far as time spent in obtaining professional training is concerned, this is a relatively short period when compared to the time which doctors, dentists, lawyers and research scientists spend. Lessening the time spent by a liberal arts college graduate in obtaining professional training also makes it easier for him to go to graduate school in engineering if he chooses.

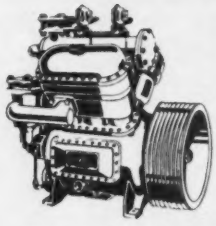
There are seventeen liberal arts colleges

participating in the Combined Plan with M.I.T. These schools are Amherst College, Bowdoin College, Carleton College, Hamilton College, Miami University, Middlebury College, Oberlin College, Ohio Wesleyan University, Pomona College, Reed College, Ripon College, St. Lawrence University, Washington and Jefferson College, Wesleyan University, The College of William and Mary, Williams College and the College of Wooster. They are chosen to participate in the Combined Plan because of their high academic standards. Because of confidence in the academic standards of these colleges, any student that is recommended to M.I.T. for study under the Combined Plan by one of these schools is automatically accepted by M.I.T.

Many other technical schools have combined liberal arts and engineering plans of study. For instance, Oberlin College also had a combined plan with Case Institute of Technology in Cleveland. Cal. Tech, Carnegie Tech, and Rensselaer, to mention a few engineering schools, have combined plans with various liberal arts colleges. The mechanism of these plans may not be exactly the same as the M.I.T. Combined Plan, but the goals and general arrangements are the same. This idea, then, of a combined liberal arts and engineering education is not limited to M.I.T.; it is part of an attempt in many technical schools to broaden the engineering education and give the engineer a chance to acquire a broader outlook. This and other efforts in this direction represent progress in improving the engineering education in this country.

New Low-Temperature RCA Victor Test Laboratory Sub-cooled with FRICK

Refrigeration



Temperatures down to 85 degrees below zero are maintained by a 3-stage Frick system in this altitude-temperature-humidity chamber of the Radio Corp. of America at Camden, N. J., where two other test rooms are also cooled to minus 100°F. by Frick refrigeration.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

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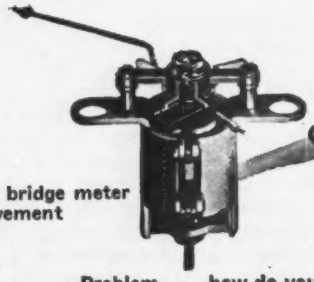
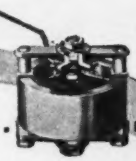


full bridge meter movement

CREATING SOMETHING SMALLER...



unique core type movement

TO BUILD SOMETHING BIGGER

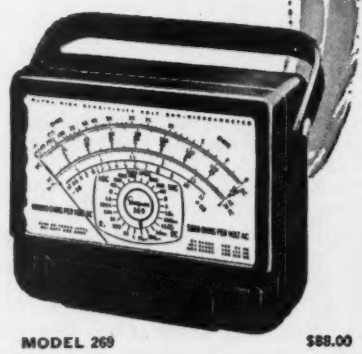
Problem . . . how do you engineer a 100,000 ohms per volt sensitivity tester so that it will fit into a 7 inch case with a dial that is practically as large as the case?

The Simpson full bridge meter movement has performed exceptionally well for many years. This new challenge, however, meant one thing—the compact meter movement had to be made even smaller . . . more sensitive.

A unique core type movement was designed by Simpson engineers. Its specifications for accuracy are so extremely rigid that unusual production methods had to be devised to build these core type movements in commercial quantities. Simpson engineers did this, too.

Today, laboratories, manufacturers, schools, and television servicemen have available to them a completely portable volt-ohm-microammeter . . . an electronic tester so sensitive that many of its 33 ranges are comparable in sensitivity to those of a vacuum tube voltmeter. In addition, this unusual product eliminates practically all of the disadvantages of a VTVM . . . drift, tube replacement, warm-up time, resulting in necessity for recalibration,—no AC outlet or line cord required.

This is just one more example showing what creative engineering can do to solve a problem.



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FIRST COMMERCIALLY AVAILABLE 100,000 OHMS PER VOLT SENSITIVITY VOLT-OHM-MICROAMMETER IN A 7" CASE

Simpson ELECTRIC COMPANY

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Well worth the reading

(and it's yours for the asking)

The simple step of sending a postal card for the booklet pictured here may well have a tremendous influence upon your future.

Quite frankly, it is written to attract promising young engineers to the opportunities awaiting them at Goodyear Aircraft Corporation.

The facts it presents are as sound as they are inviting—for it gives the story of an engineering-minded organization that is part of a basic industry, one which will always be doing business come peace or war, boom or bust.

It is the story of a pioneering-minded organization which has contributed many important advancements to aviation's progress.

It traces the role of Goodyear Aircraft in the building of complete airships and airplanes, in the research and designing of countless aeronautical components—including helicopter fuselages, droppable fuel tanks, transparent canopies, radomes, bonded sandwich structures as well as radar, guided missiles, wheels, brakes, and electronic computers.

It tells why Goodyear Aircraft offers you unlimited possibilities if you can qualify for membership in an engineering family which has set such an enviable record in the exciting and ever-growing field of aeronautics.

It's well worth your reading. We invite you to send for it — and, if you desire, to accompany your request with a brief resumé of your qualifications or experience.

ADDRESS: Dr. K. Arnstein, Vice President of Engineering, Goodyear Aircraft Corporation, Akron 15, Ohio

GOODYEAR AIRCRAFT

THE HYDROSTATIC TEST

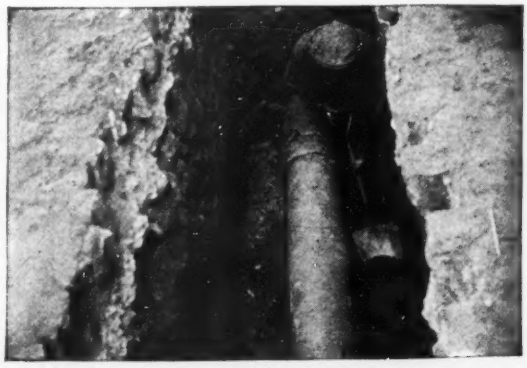
Nobody can buy a length of cast iron pipe unless it has passed the Hydrostatic Test at the foundry. Every full length of cast iron pipe is subjected to this test under water pressures considerably higher than rated working pressures. It must pass the test or go to the scrap pile.

The Hydrostatic Test is the final one of a series of routine tests made by pipe manufacturers to assure that the quality of the pipe meets or exceeds the requirements of standard specifications for cast iron pressure pipe.

Few engineers realize the extent of the inspections, analyses and tests involved in the quality-control of cast iron pipe. Production controls start almost literally from the ground up with the inspection, analysis and checking of raw materials—continue with constant control of cupola operation and analysis of the melt—and end with inspections and a series of acceptance and routine tests of the finished product.

Members of the Cast Iron Pipe Research Association have established and attained scientific standards resulting in a superior product. These standards, as well as the physical and metallurgical controls by which they are maintained, provide assurance that cast iron pipe installed today will live up to or exceed service records such as that of the 130-year-old pipe shown.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.



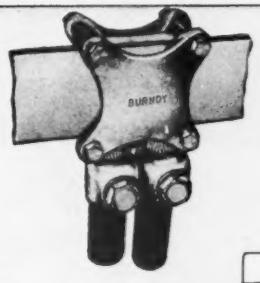
Section of 130-year-old cast iron water main still in service in Philadelphia, Pa.

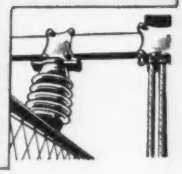
CAST IRON PIPE SERVES FOR CENTURIES

PROBLEM: To join or terminate any electrical conductor—anywhere

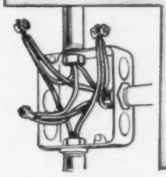
SOLUTION: BURNDY CONNECTORS

Wherever electrical conductors are joined, terminated, clamped or grounded —you'll find Burndy connectors completing the circuit . . . safeguarding the circuit. Right down the line, from mammoth industrial or utility installations to house service drops . . . from B-36's to washing machines Burndy connectors are included in the most exacting engineering specifications. Wherever your job takes you, you'll find Burndy connectors on the job, too. Here are just a few examples of Burndy-engineered connectors:



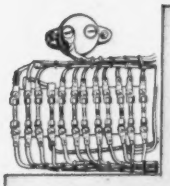


BURNDY BARTAP
Burndy has developed a complete line of heavy-duty connectors—standard and special shapes—of high current capacity. Used in utility substations, industrial power houses, hydro-electric projects, etc.



BURNDY SERVIT
Most versatile, efficient and popular split-bolt connector for splices, taps, dead-ends. Used and re-used for sizes #12 Str. to 1000 Mcm. Variations available for aluminum and steel conductors, and for combinations of these and copper.

BURNDY HYSPLICE
These compression splices, installed by Burndy hydraulic tools, are used in power transmission lines, where joints require maximum conductivity, highest mechanical strength.



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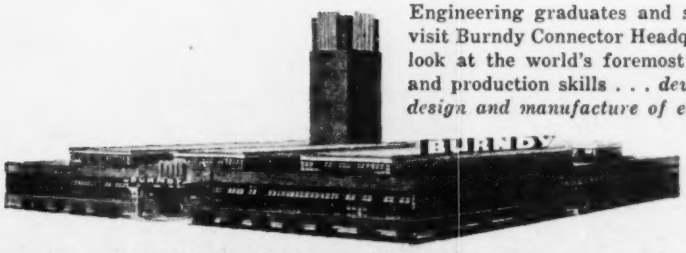

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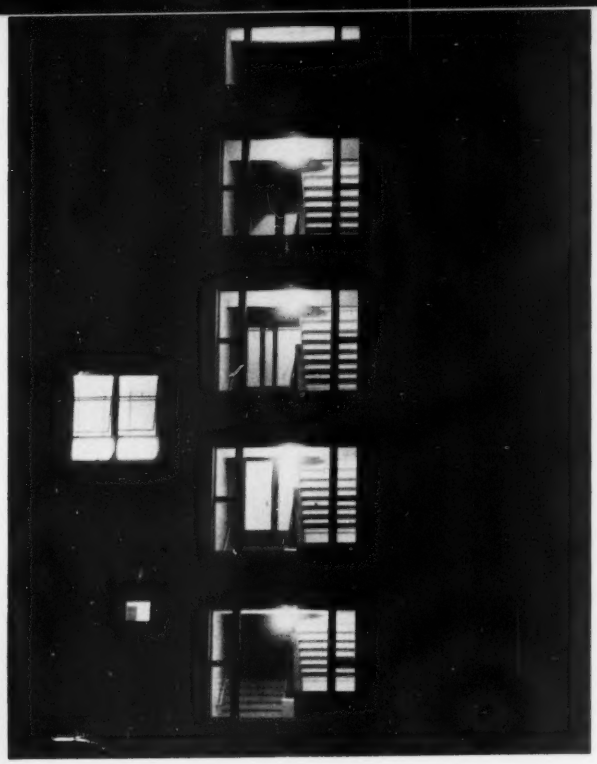

Photos
by
Malcolm MacLeod, '55

tech engineering news

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from the editor's notebook

Safety Engineering

T.E.N. was indeed pleased to learn that the Institute Committee had the maturity and wisdom to declare freshman hazing an illegal act. This step of justice was taken, say the supporters of the action, primarily in the interest of safety. We were surprised how such a simple answer to the problem of dangerous hazing could so easily be eliminated simply by the elimination of all hazing. It is difficult to see why such a simple solution was not evident earlier.

Now that the Institute Committee has taken a step in the right direction it should continue its crusade for safety by outlawing all other such dangerous activities. Somebody might slip on the tiles of the swimming pool and crack his skull, so swimming should be abolished. Baseball and softball always present the possibility of getting hit in the eye with a ball or bat while soccer and rugby are sports which present fair opportunities for cracking ribs. All these sports should be abolished! By simply passing a few laws, the Institute Committee could easily make this M. I. T. community a much safer one! How simple and easy!

If only the state legislature would follow the Institute Committee's sage policy it could bring the total number of automobile traffic accidents down to zero. Instead of regulating such details as speeds and automobile performances, the legislature could pass a law making the act of driving an automobile a crime. Of course, this would not be quite fair with the safe drivers, but just think of all the traffic accidents eliminated!

Yes, the Institute Committee has taken a most judicious step, and now that we have been awakened, we should not allow it to cease without the abolishment of all other jeopardous activities around M. I. T. Perhaps, if all of the governing bodies of the world followed this policy we would revert to the world of the caveman (with guaranteed-by-law super-safe caves). But just think how safe we would be!

D.E.

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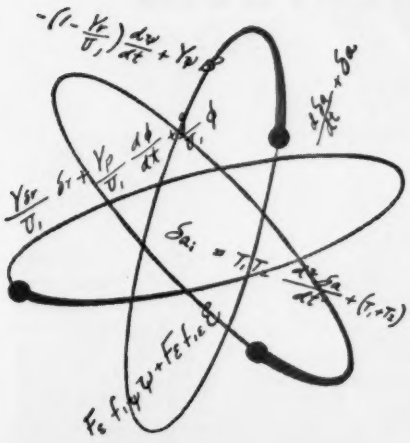

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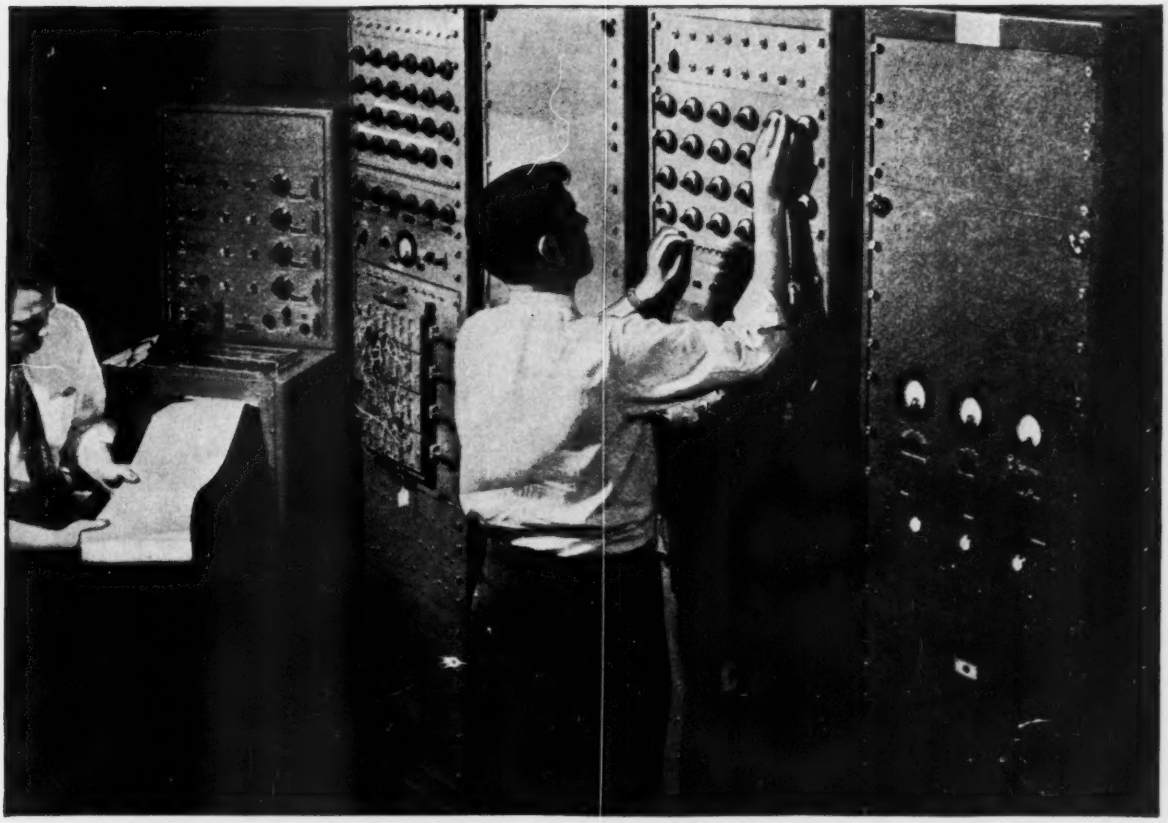

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thoroughbreds of motordom

by Peter C. Bulkley, '55

"You're driving an automobile that can do 100 miles per hour. Not just 100 on the speedometer—that can be anything from seventy-five up—but an honest 100 by stop watch. You are at the beginning of a five-mile straight stretch of concrete, so you stick your foot into it, hit and hold the 100 mark. Ahead of you there is a parked car, white, low and mean-looking. As you pass, the fellow behind the wheel guns his engine and starts after you. You keep your foot hard down, and well before you've covered a mile, you hear a whoosh, and the white car has passed you. Another quarter of a mile and he's out of sight."[1]

The car capable of such a performance is a Mercedes Benz Type W 125 which is now sixteen years old. Cars of this general class are of the type which this article treats. Acceleration, however, is not the only requirement necessary for such a competition automobile. The brakes must be capable of allowing the car to negotiate the curves and turns of road racing with never a trace of fade. These factors along with suspension and body design produce a successful racing car which lacks only a man able to drive it and mechanics to tune it up. They can be hard to find.

From the experience gained on the track, the sports cars of Mercedes Benz, Alfa-Romeo, Bugatti, Maserati, and, in recent years, the Ferrari are developed. These cars retain the basic features of the competition models but are finished with more comfort in mind. Of course they are not cheap. Workmanship of the quality found in these cars is expensive, and only the finest material is worthy of being worked by these craftsmen. They range in price from $8,000 to $15,000 and up. For this price the buyer receives an automobile with not only distinctive lines and comfort, but most important, a car that can give him a joy from driving that is difficult to imagine even exists. For here is a car that will respond to his slightest whim. Firm steering that will take him through almost any curve at any speed, quick changing gear boxes for tremendous acceleration, and brakes, that when applied hard, give the sensation of hitting a wall. Driving one of the masterpieces puts the feeling under one's skin that can only be satisfied by ownership. More men have succumbed to it than to the perfumes of Paris.

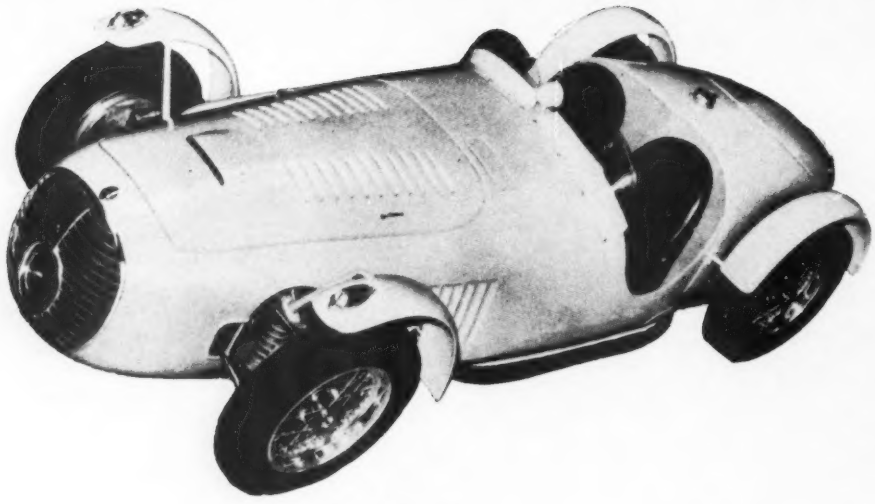
The top car of the past few years has been the Ferrari driven by Alberto Ascari of the factory racing team. This is a remarkable feat as Ferrari built his first sport car in 1947 and first grand prix model in 1948. Also built in Moderna, Italy, is the powerful Maserati. This car, at Berne, under the capable hands of Fanigo placed first thereby winning over the Ferrari entry. His average speed was 101.72 miles per hour against

1. Purdy, K. W., KINGS OF THE ROAD, Little, Brown, and Co., 1952.

Mercedes 300 SL

Bugatti 101 Convertible

Ferrari

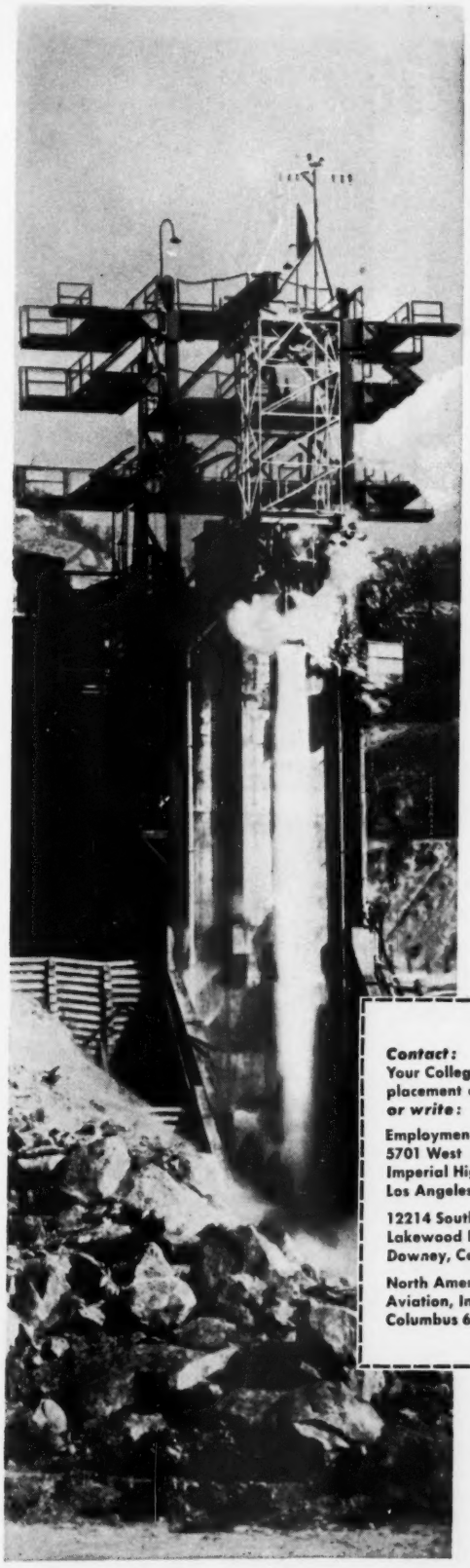


Maserati

erage speed was 101.72 miles per hour against Ascri's speed in the Ferrari of 101.35 miles per hour. These two liter Maseratis are giving the Ferraris a run for their money. Another Italian contribution is the Alfa-Romeo Company whose products raced against those of Buggati of France and Auto Union and Mercedes Benz of Germany during the prewar years. As new features are introduced by the various companies, other names will take over in the number one position. For example, the new disc brakes on the Jaguar was the winning factor in the Le Mans Race this year.

These cars, we realize, represent only one fraction of the sports car field, but they are the ultimate achievement of the automotive industry. Others are, of course, outstanding, but space doesn't permit further discussion. As long as men love a powerful but safe automobile and listening to the music an engine produces when turning at 6000 RPM—a whine which is indescribable—let us hope that the building of these cars will not become a lost art!

Alfa Romeo Coupe Florida by Ghia (above) and Ferrari America (below)



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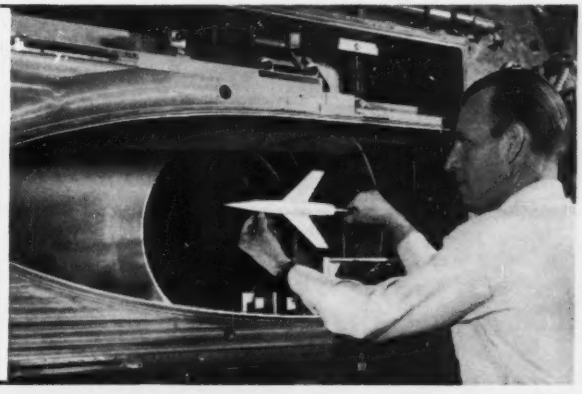

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Quantity production of polymer was only a beginning. A whole set of new and unusual problems arose in spinning the fiber, because polyacrylonitrile decomposes before it melts, and it dissolves only in high-boiling solvents.

A team of Du Pont technical men—chemical and mechanical engineers, instrumentation specialists, metallurgists, and materials handling experts undertook to find a solution. Here are a few of the problems they met:

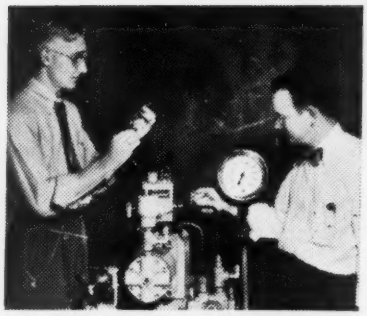
1. Solve problems in heat transfer and fluid flow arising from the fact that the spinning solution must be blanketed with inert gas to prevent fire hazards.

2. Design a system for controlling the temperature of the viscous spinning solution within ±0.5°F. at hundreds of points in the plant.

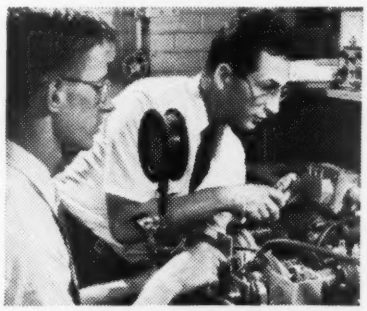
3. Design new mechanisms for winding yarn at high speed without any deviation in yarn tension.

4. Design air conditioning and ventilating systems to remove fumes from specific spots, but still allow easy access to all areas.

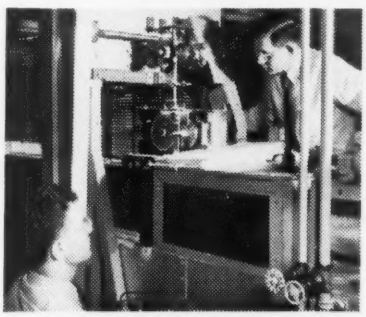
Among Du Pont's many research and engineering activities, Design and Development jobs provide great opportunity for the knowledge, ingenuity, and teamwork capacities of men in a great variety of technical fields.



The characteristics *of a super-pressure pump, designed by Du Pont engineers and made in Du Pont shops, are studied by Ralph C. Grubb, B.S.M.E., Tennessee '51, and Paul D. Kohl, B.S.M.E., Purdue '46.*



Albert Rand, *B.S.M.E., M.I.T. '50 (right) develops controls for chemical equipment.*



Carl Hellman, *B.S.Ch.E., Syracuse '50, and J. M. McKelvey, Ph.D.Ch.E., Washington '50, search for new ways to coat plastic on wire.*

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the pre-pilot plant

by Tom Boyle, '57

The development of a commercial chemical process to the point where it is practical to build a plant is an important phase of chemical engineering. Given a chemical reaction which produces some useful chemical, the engineer puts the reaction through a series of tests designed to judge its true value.

The batch test, as its name implies, is strictly a hit or miss proposition where a given amount of reactants are put into a container and subjected to various conditions in an effort to find the optimum conditions for the reaction. Many reactions look very plausible under batch conditions, only to become too complicated to be practical under actual plant conditions. Thus, every time any engineer decides to build a plant to utilize a given reaction, he runs a risk. This risk can be translated into dollars and cents, a medium that everyone understands.

To minimize the financial risk involved in plant design, the engineer resorts to small scale plants which try to simulate actual plant conditions. These plants are commonly called pilot plants. Despite the fact that the pilot plant is small compared to an actual plant, it must be very complete as to equipment detail, and it is consequently rather high priced. With this in mind, consider the case of a commercial chemical design company considering a new process about which little is known. After they complete bath tests, there is still much left to be learned about the process. To incur the expense of piloting the project would be foolish, if they could have an accurate estimate of the practicality of the reaction without such expense. This is where the pre-pilot plant comes into use.

The pre-pilot exactly fills the gap between batch tests and pilot plants. Its equipment, being small, is very cheap, at least as compared with normal research expenses. Consider, also, that when a new process is being developed, it is often necessary to make major changes. These can be made very cheaply if the equipment is small and easily workable. The best way to see the usefulness of the pre-pilot plant is to take a typical one and examine its good and bad points.

The value of the pre-pilot plant becomes evident upon examination of the type of equipment used. Take, for instance, a solid, liquid reaction that runs at normal pressure. On the batch scale, the reaction time is determined. This, then, determines the number of agitated tanks that will be used on the true plant scale. Once this is determined the process can be set up on a lab scale. A glass blower is given general plans for the equipment to be used. For the tanks of the reaction, for instance, he can adapt standard beakers. Each beaker may be fitted with several outlets for the various flows. Since the reaction is between a solid and a liquid, agitation will probably be required. Laboratory supply companies put out small electric motors just for this type of application. The agitator itself may be made of glass, especially in the case where ordinary metals might be

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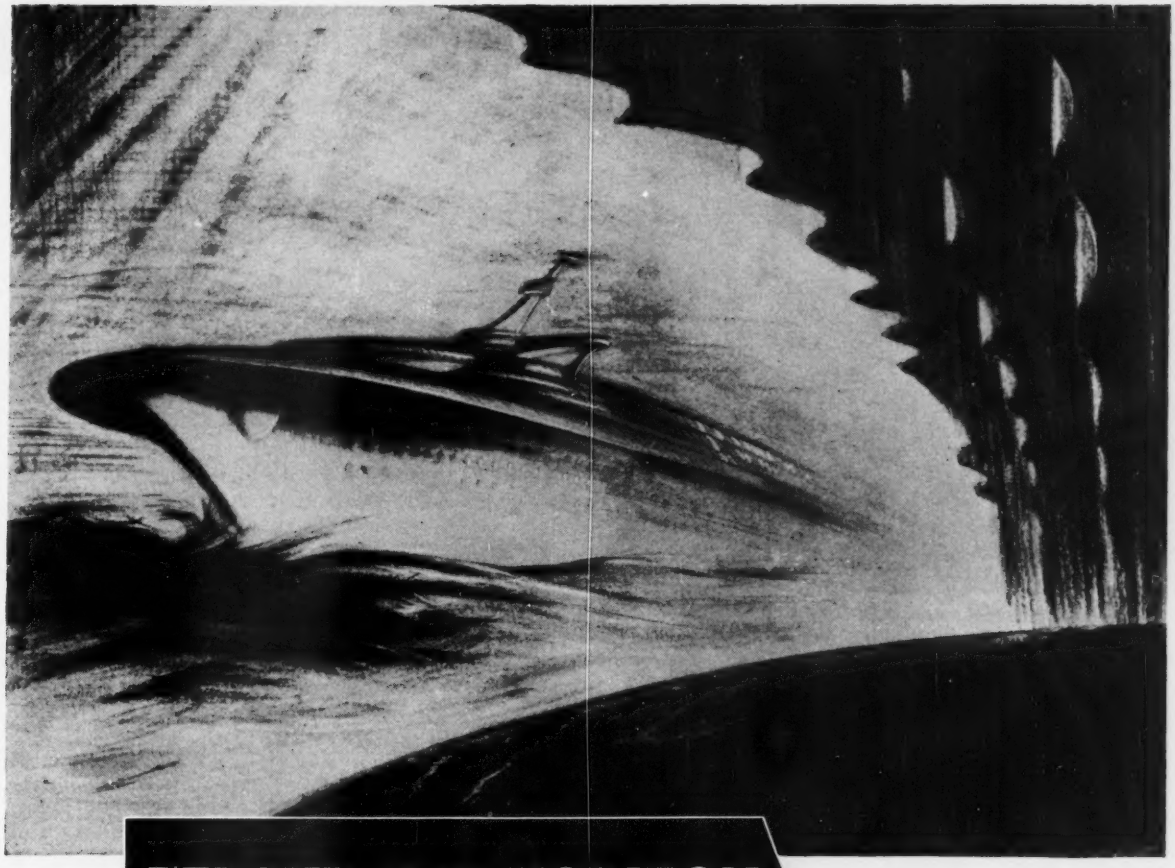
attacked by the reacting substances.

If the pre-pilot plant is to simulate to any appreciable extent actual plant conditions, it will probably be "run" continuously for a period of several days. In this case, the flows of the reactants into the beakers must be set upon a semi-continuous scale. Small pumps and siphons serve the purpose very well. Sometimes certain flows, particularly solid flows are manually controlled. This is especially true if the pre-pilot plant is thrown together in a hurry when someone gets a "hot idea." Often, on the pre-pilot scale, an entire process can be set up in an area equal to the size of an ordinary room, provided the area is equipped with the ordinary laboratory gas, compressed air, and water lines.

One big advantage of the pre-pilot plant is its small personnel requirements. While a crew of between five and ten operators and engineers are required to operate a full size pilot plant, the lab scale plant may need only two people. Usually the equipment is cared for by an operator, while all data is taken by a chemical engineer or chemist. Even the operator can be selected more for his experimental ability than for his familiarity with machinery.

Since this is a process development plant, the data taken is of the utmost importance. Perhaps product concentrations are to be determined. If the plant is set up by a commercial design engineering company, they probably have a laboratory to which samples may be sent. However, in order to control the plant, titrations or other checks will have to be made on site. All data taken is recorded in the process log book, to be examined later when the question of further research versus dropping the project, comes up. If one of the products is crystalline in nature, it might be necessary to watch developments in crystal formations. A microscope located near the plant itself, will be employed. It will be fitted with a camera attachment to more accurately record any unusual changes.

It is obvious that an array of beakers and small electric motors is a long way from a half million dollar plant. The pre-pilot is only one stage in a long process of elimination. It is a very necessary step, since a commercial design engineering company must test many processes. If they were to pilot each process, any appreciable percentage of failures would consign the company to that familiar trouble, lack of money. If, on the other hand, they were to try to estimate a reaction's value without sufficient testing, they would lose many valuable processes. The pre-pilot plant is, then, a valuable tool to the chemical design engineer.



BEYOND THE HORIZON....

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the m.i.t. experi

by Russell A. Chihoski, '54

A short lecture is delivered before getting to work.

Many good engineers are not very well acquainted with the mechanics involved in the manufacture of the multitude of metal products. All metal parts for machinery, vehicles, structures and a million other things are shaped from the homely ingot either by metal deforming (rolling, forging, etc.) or by casting. Casting is an indispensable method of creating the intricate and odd shapes in irons, steels, bronzes and aluminums, both ounce-wise and ton-wise.

It seems amazing to me that people can use all sorts of machines and gadgets, even design and invent these things like good Tech men do, and yet not know what a casting is. *If the piece of metal nearest you is not a casting, a casting is a most vital part of the machine that made it.* It is odd that most persons can see how a press can hammer out a toy but they cannot describe how one is cast. Casting is not a complicated or amazing operation, although it is fascinating. A casting is not a rare thing and the industry is not small. It ranks behind only machinery, petroleum and automobiles.

At Tech a group of students have banded together in a student chapter of the American Foundrymen's Society. They have realized the advantage gained in supplementing their substantial general education with specialization in this field. It is no mistake to concentrate on a big industry that will never disappear. They look to gaining competence in conducting casting processes. They will feel more expert than a green engineer or designer. In addition to holding about six dinner and technical meetings a year, and doing summer work for interested companies, the group operates the Experimental Foundry.

The most vital function of the future foundrymen is this Experimental Foundry run exclusively by students. Saturday mornings, every other week, this group meets in the M.I.T. foundry laboratory and conducts the program for the day. Actually this is their little pilot plant for education and for testing operations and ideas. But Experimental Foundry is not synonymous with the American Foundrymen's Society. Since another purpose is to familiarize the engineer (and humanity) with the casting process anyone in the Tech family is invited to join the Experimental Foundry. Without prejudice they may help or invent or direct and make their own castings according to their ability. Each Experimental Foundry member gains what the American Foundrymen's Society member gains. He gets not only the casting he wants but something more valuable, and that is a little familiarity with the process.

What metal will be poured, and how much, what experiments will be made, whether to use the cupola, the induction, gas or arc furnace—the whole program will be laid out by members. They make their own molds for their own castings, bookends, artwork, parts of a machine or invention. All are valuable items to the maker.

Last year the cupolas were not operating, having been only partially installed in the foundry, so only a little gray iron has been run, but much has been made of steels, aluminum, bronzes and iron alloys. But there is an exciting thing, a cupola. It is ignited and charged like a blast furnace, then watched and pampered so pigs and scrap melt; so coke does not burn too fast or too slow; so 500 pounds of molten iron does not get cold. When it is ready, the plug is knocked out of the breast plate and the white hot iron is tapped.

The furnace is charged.

mental foundry

But if it does not come out, one must quickly get an oxygen lance and blaze away through the solid barrier to the liquid and then get out of the way. If nothing will move, the "stack is dropped" and the whole blazing mess drops out the bottom before there is a dynamite proof column of solid iron and coke in the cupola cylinder. These things happen only rarely (except when we play with variables), but they are fun and somewhat missed as gas, induction, or arc are most commonly used now.

The schedule of the day parallels normal industrial conventions, but sometimes a change is made in one or several variables in the operation. The reactions and changes in the results are carefully noted. Often in some corner several men are working on their own scheme testing some new ideas with the day's melt. Sometimes the whole day becomes an experiment such as the producing of ductile iron.

Activity starts at nine in the morning. By eleven the molds are made. After most of the molds are made, and the metal is being melted, everyone is called to a corner where preparations already made are discussed, and results are calculated and predicted. An expert or professor is invited to come up and discuss the technology, metallurgy and phenomena related to the day's work. The discussion and argument that follow shakeout supplement this and offers, in part, an explanation of results. During the year several bulletins discussing the runs are written up for the members.

The molten aluminum is removed from the furnace.

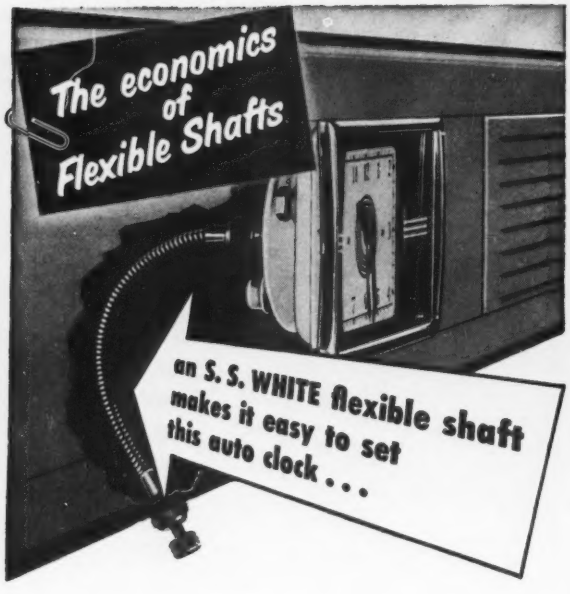
The aluminum is poured.

After the metal is poured and begins solidifying in the molds, everyone goes off to eat the hot lunch cooked up by some of the boys. The twenty-five cent charge pays for only a part of it. This is a delightful feature of the morning.

The climax of the day comes when the participants shake out the hot castings. It is like Christmas morning, everyone eager to see if he got what he ordered. The anticlimax is cleaning up. Each must leave the foundry as clean as he found it. In order to expedite this, everyone cleans before quenching, sandblasting, grinding, or cutting his castings. Otherwise all would be drawn away from that final chore rather than eager to finish it. Usually all foundry work is over before one o'clock. Then everyone's time is his own. He may finish his castings there or drag them home or just hang around in a bull session. When everything is done the member feels he has had his successful day when he has made a fine casting or learned something really interesting or valuable.

One sees that it is somewhat empirical, somewhat obvious, but he would feel that it is a refreshing application of some of the science he has learned. Businessmen and engineers begin to see how the economics of foundry maintenance and design and materials employment are the factors in profitable castings production. Even exposure to the Experimental Foundry can help business perspective, as well as give a scientific and mechanical feeling for this operation. This can be the Tech man's first intimate contact with a full industrial process.

The magnitude and scope of the metals industry is enormous. If you are a mechanical engineer or metallurgist, you will probably be in the field. If you choose I, V, IX, X, XIV, XV, XVI, it can be your choice. Casting has its own fascination, its own problems and technology. It is only recently that this necessary industry has come to more fully appreciate technology and science. The result



When this automobile clock was designed, its manufacturer had in mind the probability of varied instrument panel locations with the resultant need of an adaptable coupling to the control knob. He chose an S.S.White flexible shaft to do the job. As the illustration shows, this simple hook-up permits both the clock and the control knob to be located in its most advantageous position.

* * * *

Many of the problems you'll face in industry will involve the application of power drives and remote control with the emphasis on low cost. That's why it will pay you to become familiar with S.S.White flexible shafts, because these "Metal Muscles"® represent the low-cost way to transmit power and remote control.

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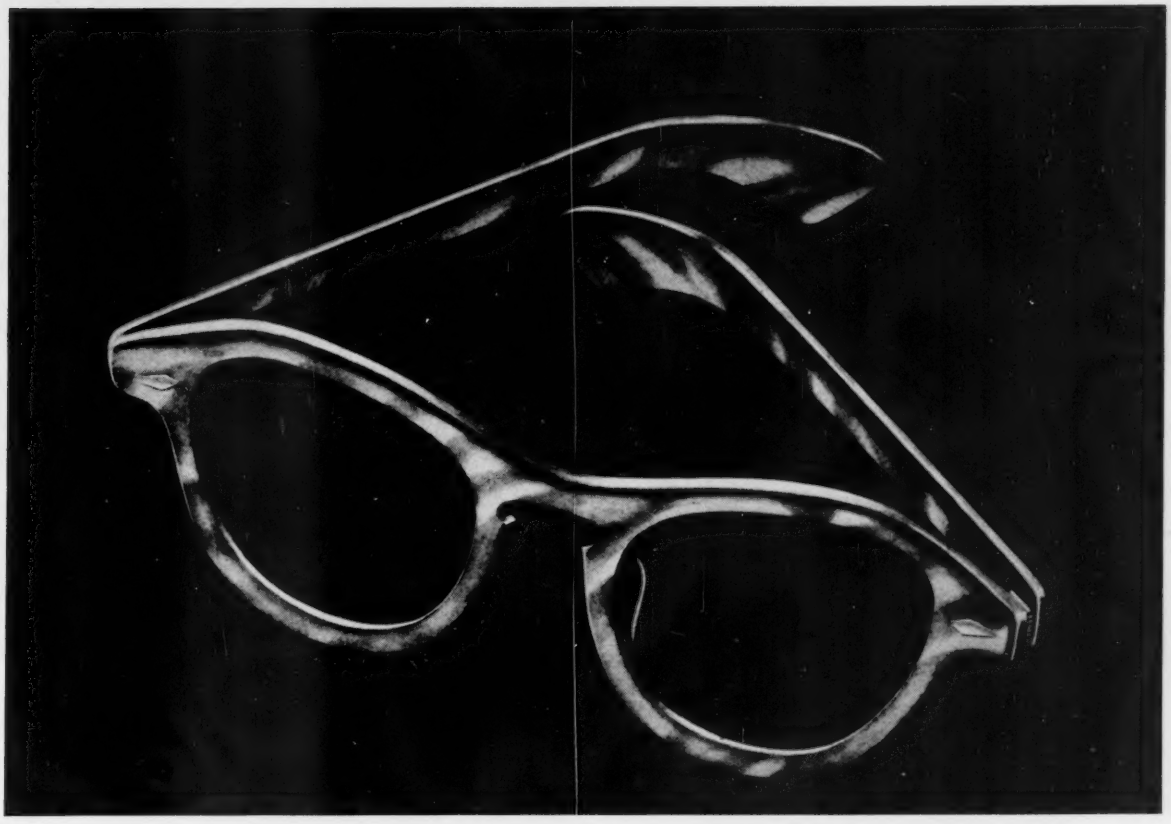
The technique of mold making is demonstrated.

of this is that mechanization and redesign in plants and science of metals, sands, and processes are virgin fields for the creative and inquisitive. Present-day directors are also looking for technical men almost exclusively for operational and supervisory duties. I know several men who graduated just a few years ago who are assistant managers of multi-million-dollar plants.

The student American Foundrymen's Society members are convinced of their field. They energetically strive to become more familiar with all aspects of the castings business. The Experimental Foundry is one means. Then too, they feel that the more men who know what a casting is, what it can do, how it must be made, the more easily each man may conduct operations and innovations in his equipment; and the more foundry engineers we have, the higher quality and more abundant the American product will be.

They want people to visit the foundry runs on November 21 and December 5 (but you cannot participate unless you are a member). The invitation to join is open.

Participants practice with a dry pouring run.



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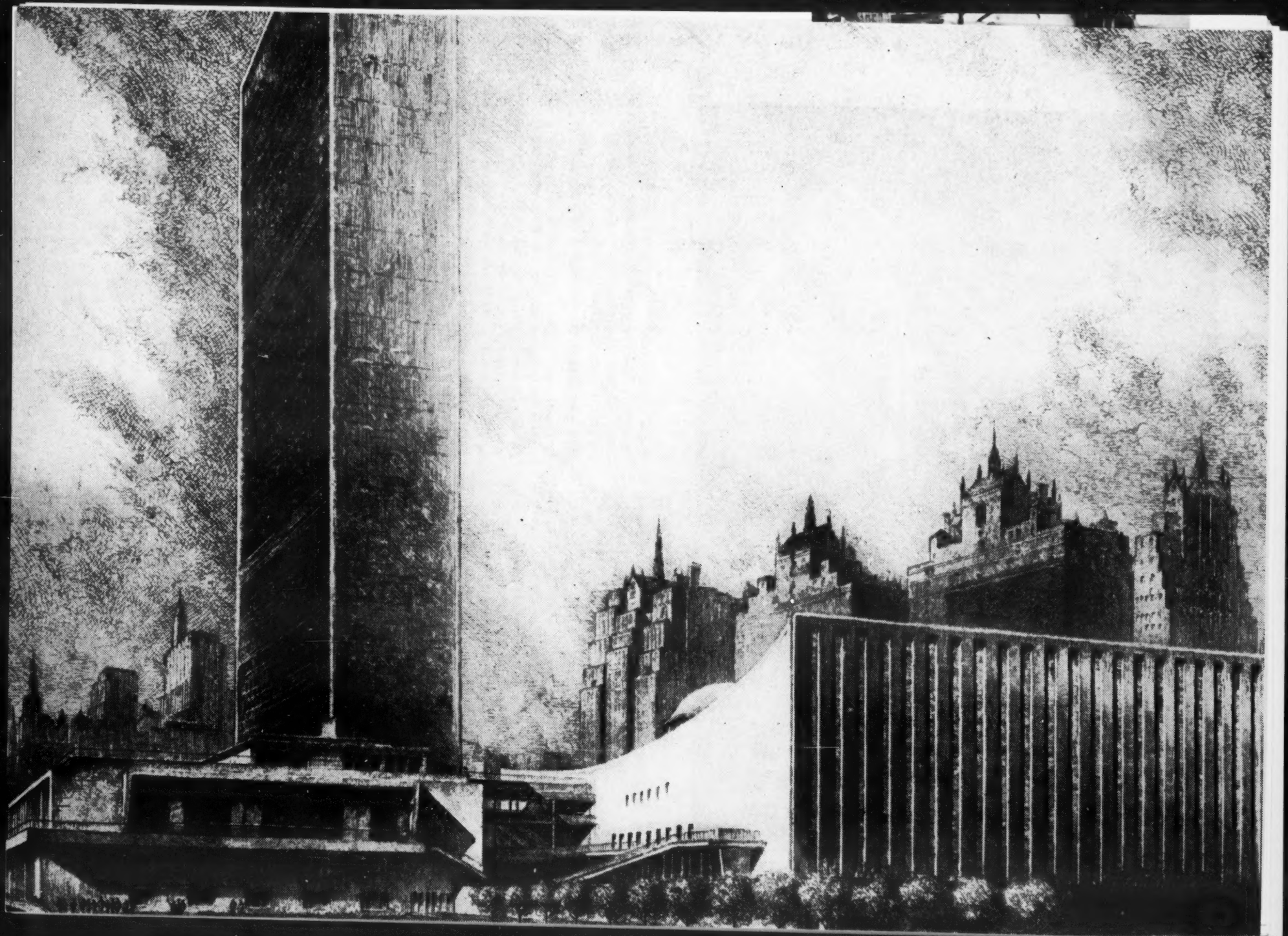

1955

by Publius, '55

October 24, 1953 marked another anniversary of the United Nations. During these first eight years of its rather turbulent existence, the UN has undergone numerous and severe tests. The record of its successes and failures is known or, at least, available to most Americans; there is no need to duplicate it here. It would seem that the time has come to call a momentary halt to our compilation of facts and to make some attempt at their evaluation. It was hoped that the United Nations would provide the means for the nations of the world to build a lasting peace; at least three wars, increasing tension between Soviet world and the West, and the current armaments race give sufficient reason to doubt that this hope has been, or ever will be, realized under the present United Nations structure. It is, however, comforting to note that the failure of the United Nations to make any significant progress toward a lasting peace has not been the result of any misuse or disuse of its power; its failures are a direct result of its *lack* of power. It is a comforting state of affairs only because it is one that can be remedied in the *immediate* future.

The creators of the United Nations displayed the greatest amount of wisdom not in their original design, but in their provisions for changing that design. Until 1955 a conference to review and make recommendations for changes in the Charter can be called only with the approval of two-thirds of the member nations. In 1955, however, it is required by the UN Charter that the subject of calling such a review conference be placed on the agenda of the General Assembly meeting that year. At that time a review conference may be convened with the approval of only a simple majority of the member nations. 1955 will present an excellent opportunity to correct some of the defects of the United Nations structure.

Speculation over the possible results of a 1955 review conference is not idealistic day-dreaming. If the current interest of the top level officials in Washington is any indication of future events, the 1955 UN Charter Revision Conference WILL BE HELD, and will result in absolutely nothing, unless the people of this and other nations become aware of the *why* and *how* and *what* of UN revision.

The changes suggested here are not presented as either complete, perfect, or final; they are merely suggestions, which may provide a starting point for popular discussion of this all important issue. It is first assumed that any changes in the structure of the UN will be made in an attempt to transform the present organization into instrument capable of maintaining peace in the world. It then follows that the UN must possess power:

1. To prohibit by international law the right of nations to use force in international disputes;
2. To make laws binding on *individuals* and national governments prohibiting construction, development, or possession of weapons beyond those necessary for the preservation of internal order, and to arrange for universal disarmament;
3. To maintain inspection, police, and armed forces capable of enforcing such international laws.
4. To bring to trial in international courts individuals and groups who violate the international laws or obstruct their enforcement;
5. To raise dependable revenue, under carefully defined and limited taxing powers.

To provide the UN with these powers it would be necessary to make the following changes in the UN Charter:

1. The General Assembly must be revised so that it may serve as legislative body capable of enacting international laws. The basis of representation in the General Assembly must be changed, possibly to take into consideration such factors as population, literacy, national economic development.
2. The Security Council must be made into a responsible executive branch of the UN, with power to enforce the international laws. The veto power must be eliminated.
3. A UN judiciary, with compulsory jurisdiction in matters concerning international law, must be established to interpret the law and render judgments under it.
4. Provisions for amendment of the Charter must be made.

"Respecting the United Nations as the living sign of all people's hope for peace, we shall strive to make it not merely an eloquent symbol, but an effective force."

Inaugural Address, Dwight D. Eisenhower

5. Secession from the UN must be made impossible.

It is thought that these points represent the minimum powers and changes necessary if the UN is to preserve international peace.

It can be seen that these changes in the structure of the United Nations, if adopted, would transform the UN into an international government or, more accurately, a world government since it would have jurisdiction over individuals as well as nations. The government would be strictly limited in powers and federal form. The term world government, however, too often

"And I think we must continue to work steadily at the frustrating task of putting international affairs on a permanent basis of law and order."

Adlai E. Stevenson

calls to mind an Orwellian picture of an overbearing super-state; a UN possessing just these minimum powers presents less of such danger than does our own United States Federal Government. However, there are sincere individuals who fear that a significantly stronger UN, by a process of gradual development and usurpation of power, might become another instrument by which we would be robbed of our personal rights and freedoms. There is a temptation to present an international bill of rights or some other written guarantees as an answer to those fears. Clearly, such documents would offer no significant resistance to any group seeking to control and use the UN for its own purposes. There is no easy way to protect ourselves from the corruption of government. Only the interest, enlightenment, and activity of the people can offer any measure of protection. It has been the American people's support of the principles contained in the Constitution and Declaration of Independence, not the documents themselves, that have made our federal system of government successful.

The fear of too much international government has been increased beyond reason, in some cases, by those who attempt to present a strengthened UN as cure for *all* the world's troubles. It would require something significantly bigger than even Orwell's fantasy to accomplish this; even then, the cure would be considerably worse than the disease.

It is reasonable to suppose that those problems arising from the current threat of a third world war and the armaments race might also be eliminated. However, in attempting to remedy other situations such as illiteracy, imperialism, disease, economic under-development, the continuing conflict between the Soviet Union and the West, and many others, which will not necessarily disappear with the end of the threat of a future war, the UN will have to rely upon the services of its voluntary specialized agencies. It might well be that future developments will require that the UN be given more than these minimum powers, but the immediate aim is enforceable international dis-armament and the outlawing of war.

All that has been said is, to some extent, dependent upon universal acceptance of membership in the revised United Nations. It is entirely possible that the Soviet Union and its satellites will refuse to accept the proposed changes. In this case, the nations accepting the changes will be forced to resort to something less than a universal federation. This, however, does not imply the destruction of the United Nations. Such a federation could assume the seats of its member nations in the United Nations and continue to use the UN as place of discussion and negotiation. The formation of a partial international government would be a significant step forward, since it would adequately demonstrate the possibilities and advantages of forming a government capable of enforcing law and preserving order between nations. It is also true (it is unfortunate that the present world situation requires mention of this point) that a federation of free nations would present a greater deterrent to Soviet aggression than does the loose system of alliances now in existence.

This article is, at best, an over-simplification of a complex problem. A more complete discussion is available in Grenville Clark's *A Plan for Peace*, Harper and Brothers, 1950.

"My purpose is merely to join with others in arousing public attention to the fact that this great opportunity is coming along, and hope that people will take advantage of it."

Secretary of State, John Foster Dulles

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about REX HIGH SPEED tool bits

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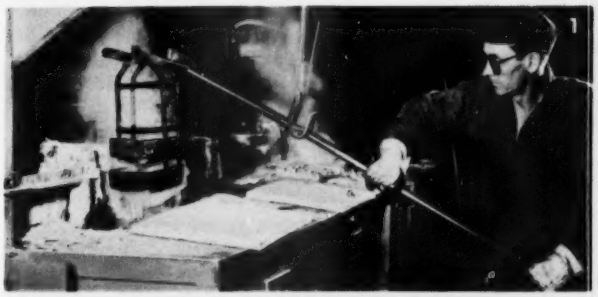

HARDENING — Small batches of REX High Speed Tool Bits are hardened in modern salt bath furnaces. The bits are then quenched in either salt or oil.

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Uniformity Each individual REX High Speed Tool Bit possesses the same uniform high quality. Each bit is inspected by the magnetic particle method . . . and representative bits are tested for microstructure and hardness. These tests control quality of the finished product . . . insure that REX bits will give higher production from each grind, and a minimum of "down-time" on your machine.

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the vacuum tube

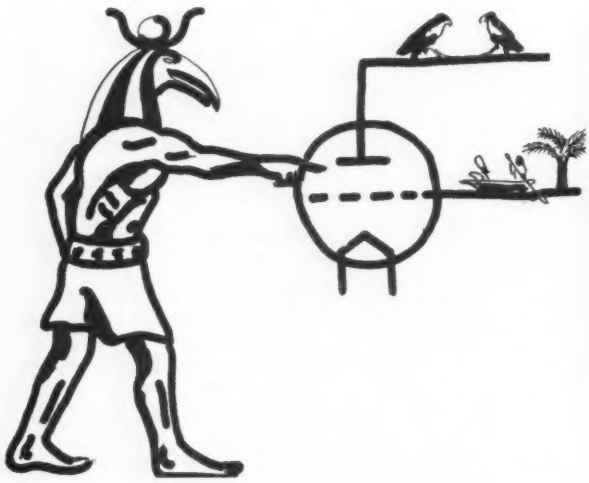
A Simple Description

by Sterling Bunnell

Reprinted from the California Engineer

To begin, we must first determine what are the essential structures which constitute the vacuum tube (or, as it is sometimes known, Mr. DeForest's tube). The filament, the grid, and the plate are usually considered to be the essential ingredients, but there is another component without whose presence the entire structure would be hard put to function, which is the glass, also called bulb, tube, or envelope. The term glass is a misnomer, as it might conceivably be made of metal, porcelain, or terra cotta. The purpose of the glass is to contain a vacuum, which leads us into a paradox. If a vacuum is nothing, how does one contain nothing? The tube contains the grid, filament, and plate, so it definitely contains something. However, it also contains a vacuum, which means that it contains nothing. This is obviously a logical self-contradiction: the vacuum tube is an impossibility. Fortunately, however, the tube is often filled with gas, and so we escape the paradox by Hegelian Synthesis.

The term "vacuum" comes from the slavic "nudnick," and is derived from the Greek EMPTX and the oriental idea of Nirvana. The Egyptian heiroglyph for vacuum is:



The next in our series of quasi-essential elements is the *base*, base meaning low or vile. Hence the base is located below the vial, unless, of course, the tube is inverted, in which case we use the term in the figurative sense only. From the base there protrude a number of excrescenses known as plugs. These plugs are cylindrical in shape, but in another civilization, in which the aesthetic is not subjugated to crass materialism, they might perhaps be helical.

Having cleared the field for action, we may now return to the basic elements which form the *Hauptsache* of the vacuum tube *Gestalt*, namely the filament, the grid, and the plate. However, since the filaments, grids, and plates which we find in everyday life bear very little resemblance to these filaments, grids, or plates in form, we will not concern ourselves with mere mundane filaments, grids, and plates, but with the Universal Filament, the Universal Grid, and the Universal Plate.

However, it is of precious little use to have filaments, grids, or even plates unless one also has an electric current, that stream of electrons casting rippling waves into the ether, as the Greeks might have said, had they known of the wave theory of electromagnetic influence, which of course they didn't.

The current goes from plate to filament, or from filament to plate, depending on whether one holds with the old idea of current going from positive to negative, or whether one is a Young Modern and believes that current goes from negative to positive. The grid, an instrument of varying potential, lies in between, and alternately blocks the current and lets it through.

It is the conception of electricity as going from negative to positive that is of vast philosophical significance. Here we can see that electricity is merely a manifestation of the fundamental dichotomy of the dualistic universe, the struggle between Good and Ungood, between Yin and Yang. If we admit that Ungood always tends to become Good (the fundamental idea of progress), and that electricity travels from negative to positive, then the plate, being positive, is Good, and the filament, being negative, is Ungood. Therefore, in the vacuum tube we see a small model of the idealogical system of creation, with the plate representing Heaven, the filament representing Hell, and the grid, with its potential varying from Good to Ungood, representing this earthly vale of struggle and confusion. The entire Yin-and-Yang cycle of the Monad merely serves to further the Universal Purpose, which in this case is operating your radio.

In summary, we may briefly say that the various processes operating the total entity are subordinated, correlated, and modulated in order to greater facilitate significant fluctuation of electromagnetic entropy in so far as is concomitant with the contingencies of communicatory commercio-mechanism.

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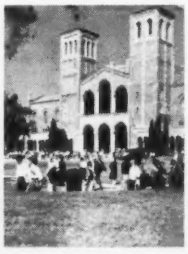

A group of participants in the Hughes Cooperative Fellowship Program (above left). Fellows study for Master of Science degrees at either University of Southern California (center) or University of California at Los Angeles (right).

This program is to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. It is open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year and to members of the Armed Services being honorably separated and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time at the Laboratories during the summer, and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

The salary will be commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance will be provided. Provision is made for an allowance to assist in paying traveling and moving expenses from outside the Southern California area.

2
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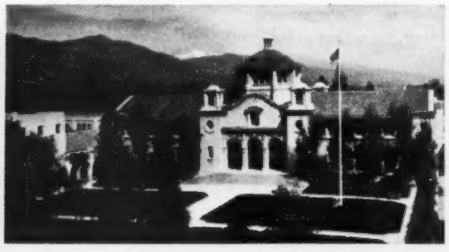
in Science and Engineering



(From left to right) Hughes 1952 Fellows Truman O. Woodruff and Allen I. Ormsbee discuss tube processing station in Electron Tube Laboratory with 1953 Fellows Roy Gould and Baxter H. Armstrong. Their advanced study is at California Institute of Technology (above).

Eligible for these fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy in physics or engineering. In summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Fellows may pursue graduate research in the fields of physics, electronics engineering, electronic computing, aerodynamics, propulsion engineering, mechanical engineering, or information theory.

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new high-speed electronic memory device that never forgets

Successful experimental operation of a very high-speed electronic memory device that promises to help solve scientific and economic problems too vast and too complex for the present capabilities of electronic computers has been revealed by Dr. Jan A. Rajchman, a physicist of the RCA Laboratories Division.

The device consists basically of 10,000 tiny ring-shaped magnets woven on thin wires.

The memory section is often considered the weakest link in present-day computers. Various memory systems now in use are either fast in receiving and giving out information or they can store vast quantities of information, but none has been able to do both. Besides, many systems are not completely reliable, i.e., they tend to "forget" or "scramble" some of the information they have stored before it is wanted by the parts of the computer that do the actual computing.

The new device appeared to offer significant advantages for computers of the future because:

1. It can "memorize" or "recall" a bit of information in a few millionths of a second. (A bit of information is expressed as "0" or "1" in a computer. In combination with other bits, it can represent numbers or words or symbols.)

2. It can store 10,000 bits at any one instant. With 100 such devices connected together, which is theoretically possible, a million bits could be stored. A million bits is more than would be needed to translate five solid pages of a newspaper into the memory's language.

3. It potentially has a very high degree of reliability, since its tiny magnetic cores never wear out no matter how much information is fed in or out. Besides, a core could hold the same bit of information for years, if this were desired.

4. It promises to be relatively cheap, as memories for computers go.

The heart of the present 10,000-core memory is a grid—or matrix—of a hundred closely spaced wires at right angles to which run a hundred more wires.

At each intersection of the wires is a magnetic core. Through the center of each core runs one vertical wire and one horizontal wire.

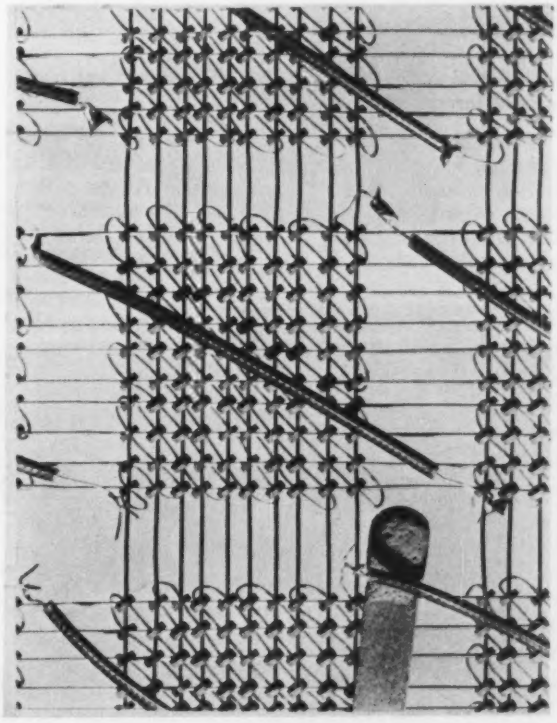
The cores, which are about the size and shape of the typewritten letter "o" and one-fifteenth of an inch thick, are made of a special ferromagnetic spinel, a ceramic-like material.

The magnetic material of the cores is such that when there is an electric current of a certain intensity flowing through the two intersecting wires a core will switch its magnetic polarity from positive to negative, or negative to positive, depending upon the direction of the current.

Current of the same intensity in one wire alone is not enough to trip the polarity. Thus only when currents are flowing in both wires, will the core at their intersection flip into opposite polarity (if it is not in that state already) causing the core to "memorize" one bit of information.

Thus by applying a current to a particular horizontal wire and a particular vertical wire only the core at their intersection may be tripped.

Recalling, or reading out, information from the memory is also accomplished by operating on one core at a time. The operation is so fast that a hundred thousand bits can be withdrawn in a second.



The core to be interrogated is subjected to pulses along its two intersecting wires. If the core is tripped into opposite polarity, its reversal of polarity creates an electrical signal in a wire that runs through the center of all 10,000 cores. If it is not tripped, no signal appears in the common wire. In either case, the nature of the bit of information it contains is determined. (If the core is tripped in reading out, it is automatically returned to its original state by associated circuits, thus no permanent erasure of information need take place.)

high speed research

by Malcolm A. MacLeod, '55

The M.I.T. Supersonic Wind Tunnel

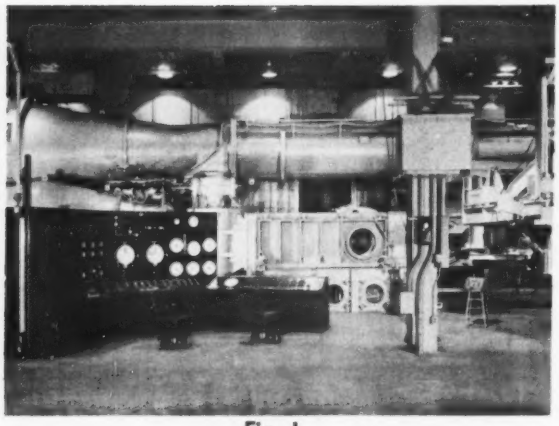


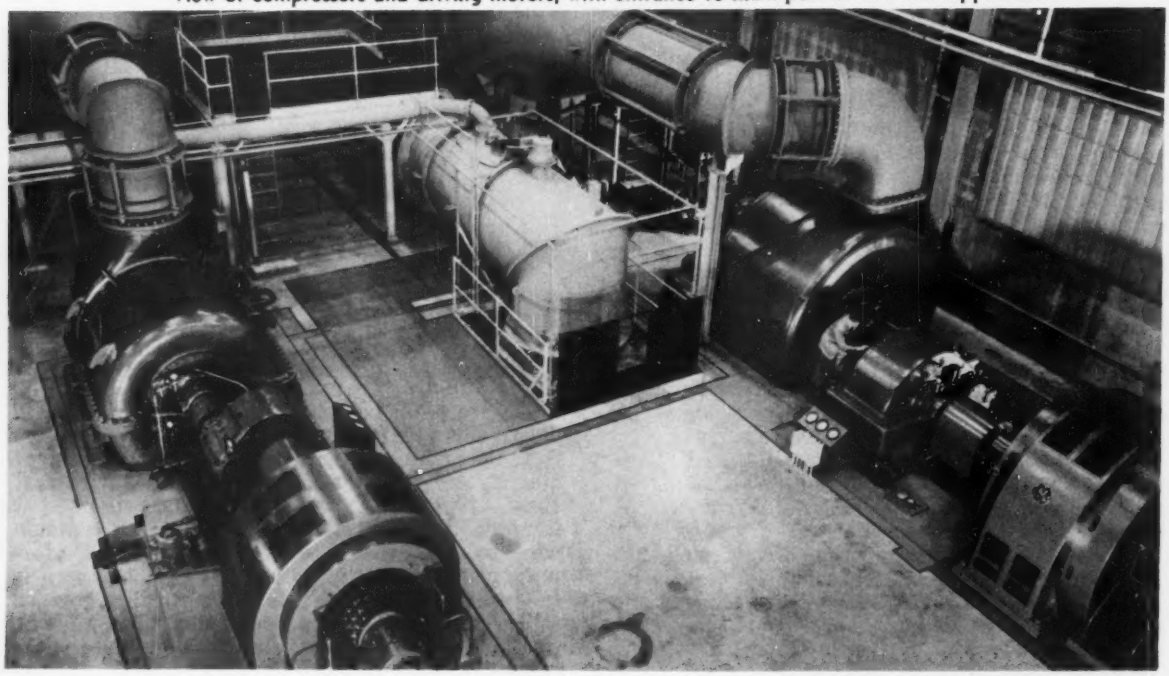
Fig. 1.
Test section and control console, with Schlieren apparatus in right foreground.

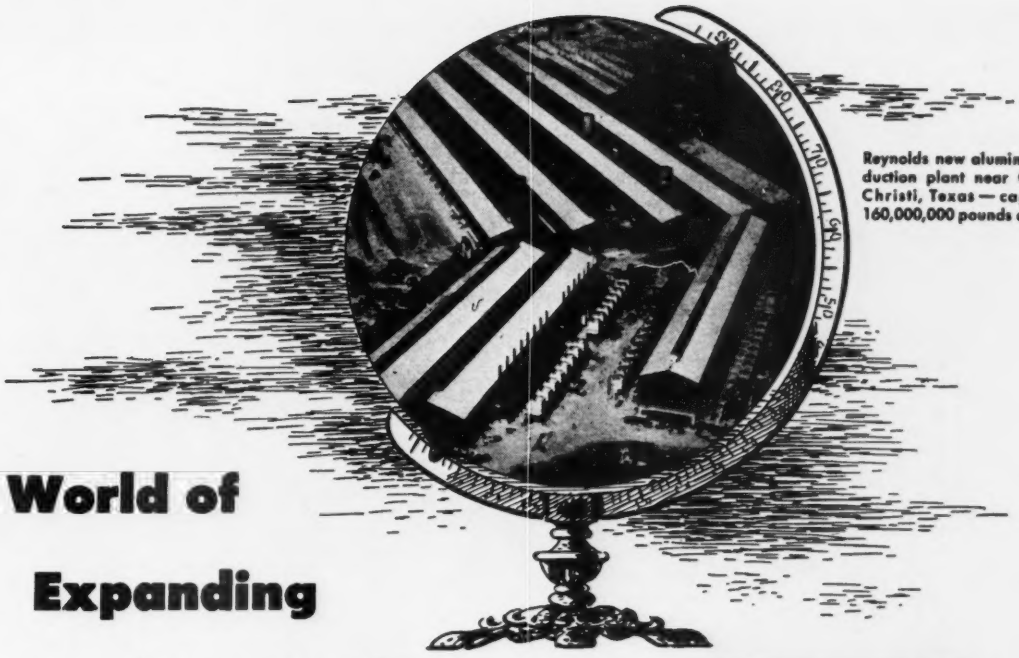
Probably few Techmen realize that at the westernmost end of the campus is situated a building which contains one of the most intricate collections of machinery and instruments available to the research scientist of today: the M.I.T. supersonic wind tunnel. It was designed and built by M.I.T. with funds supplied by the U. S. Navy. The design problem was undertaken in 1947, construction began some months later, and the first tunnel run took place in June 1950.

The building which houses the supersonic wind tunnel also houses a complete machine shop, drafting room, service shop, and offices. At the present time, the staff is composed of sixty people, of which twenty-five are engineers, mostly Techmen.

The function of the supersonic wind tunnel is to supply a ready means for observing characteristics of supersonic flight, and mainly the flow of air at those speeds, past models suspended in the airstream. The method used here at Tech for accelerating air to above sonic speeds is, essentially, a continuous compression-expansion cycle, with the test section located after one of the expansion points. The compressors (see figure 2) are of the four-stage centrifugal type, rated at 4,000 and 6,000 hp., and are driven by two wire-wound induction motors of 10,000 hp. After the air is compressed, it is passed through a water-cooled expansion chamber and thence to the main part of the tunnel. Just forward of the test section the tunnel narrows (figure 1) and leads into a De Laval nozzle (figure 4). At the throat of this nozzle the air attains sonic velocity and expands

Fig. 2.
View of compressors and driving motors, with entrance to main part of tunnel in upper left.





Reynolds new aluminum reduction plant near Corpus Christi, Texas — capacity 160,000,000 pounds a year.

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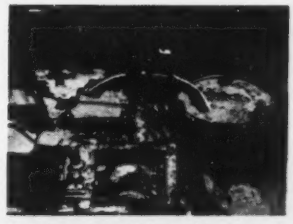
In a land noted for rapid expansion of free industrial enterprise, few companies have matched the swift and continuing growth of the Reynolds Metals Company. Now operating 27 plants in 13 states, and still expanding, Reynolds offers the ambitious engineering graduate a world of opportunity.

Reynolds operations include bauxite mining in domestic and foreign locations...chemical and electrolytic processing to produce aluminum pig ...sheet rolling...drawing and extrusion of mill and structural shapes ...foil rolling and printing...powder and paste production...finished parts and products fabrication. In these and in the allied sales and marketing operations promising careers exist for graduates in virtually any phase of engineering.

On-the-job training is the Reynolds policy—after preliminary orientation which may include basic experience in production plants for sales personnel, and sales office work for technical trainees. Liberal insurance, hospitalization and retirement programs are maintained.

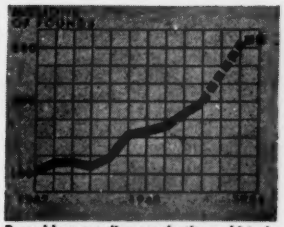
For important background information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.



Tapping one of huge battery of electrolytic cells

Sheet rolling—reverse hot mill in operation

REYNOLDS ALUMINUM



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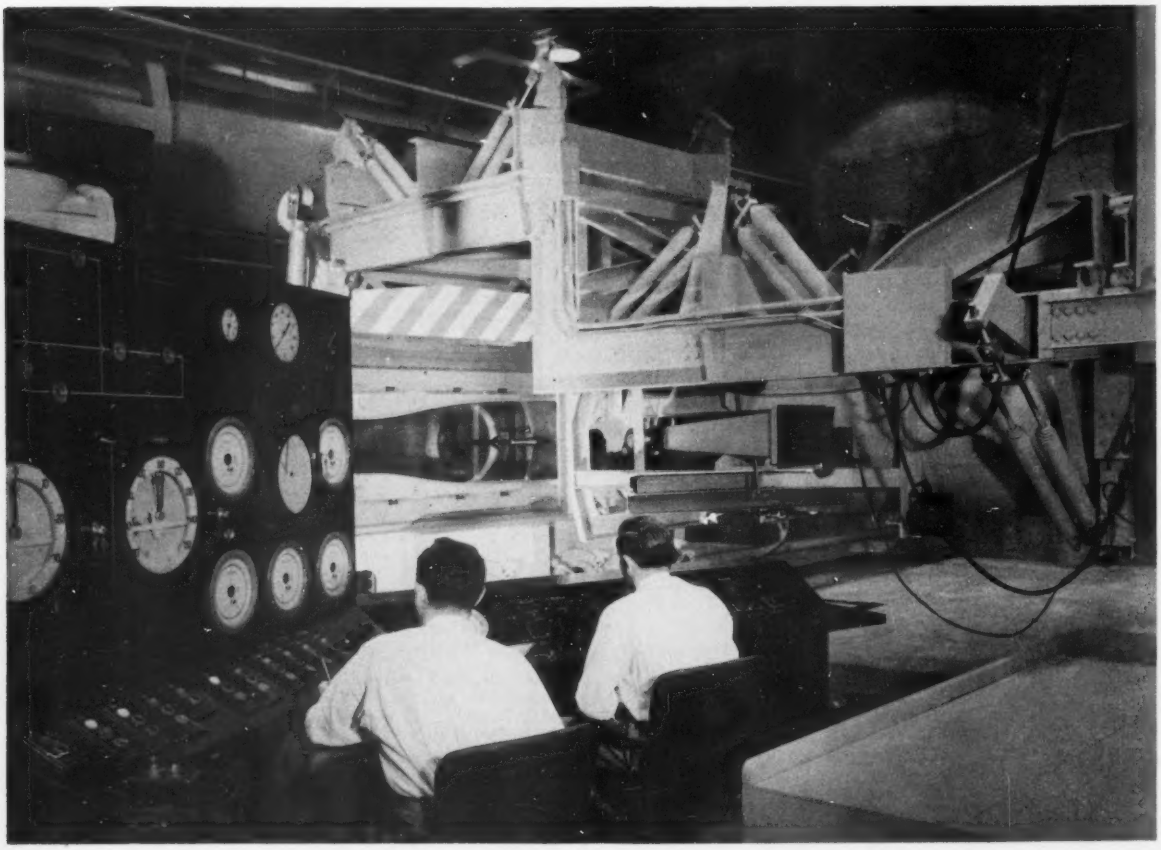
in the after-section to attain supersonic speeds. The ratio of the diameter of the exit section to the diameter of the throat determines the speed at the exit point. The test model is mounted at this exit point. After roaring past the model, the air speed gradually drops below the sonic level and is returned to the compressors to begin the cycle again. There are several features which make the tunnel versatile. The air compressors may be run either in series or in parallel, thus permitting a wide range of tunnel test conditions. The density of the air in the tunnel is thus variable; the actual range in pressures is from 0.25 to 4.0 atmospheres. At both ends of the test section there are valves which can be used to close off the section for adjustment of the model without changing the pressures in the rest of the tunnel. There are pumps to equalize the pressure in that section quickly after the adjustments have been made. Strain gauges are mounted on the model to indicate the forces at various points; these may be read from the control console. A camera with a thirty inch Schlieren optical system is used to provide test records of the flow past the model. This system is visible in figure 3, the camera and the optical system being mounted on the crane in the right center of the photograph. Since air circulating in the tunnel must be dry, there are calcium sulfate drying towers which can operate while the tunnel is running or stopped.

Figure 5 is a typical photograph made with the Schlieren system. It shows the flow past a right circular cylinder mounted parallel to the stream flow. The Schlieren system makes use of variations in the density of the air stream to produce the picture of stream flow, or shadowgraph, as it is sometimes called. Reading from left to right, the first line met with in the picture is a "shock wave" where the air jumps from supersonic to subsonic speed. At this point there is a very high pressure gradient and consequent variation in density. This enables the Schlieren apparatus to register it as a shock wave. To the right of this cone, the subsonic air meets the cylinder and is thrown around the edge with a resultant increase in speed until at a point about one-third of the length aft of the cylinder face it again becomes supersonic. This produces a diagonal, almost straight line indicative of a shock wave. These shock waves are, of course, cones, but in the photograph only the outlines of these cones can be seen. In fact, the intersection of the first Mach cone with the face of the window may be seen to the right of the beginning of the second Mach cone, where it appears to come from the rear of the cylinder.

The particular flow discussed above is a fairly simple type; the study of complex supersonic airflows is still in its infancy, but the M.I.T. Naval Supersonic Laboratory will certainly be a leader in this study.

Fig. 3.
Detail view of console, test section, and Schlieren crane, with door of test section open showing model in position.



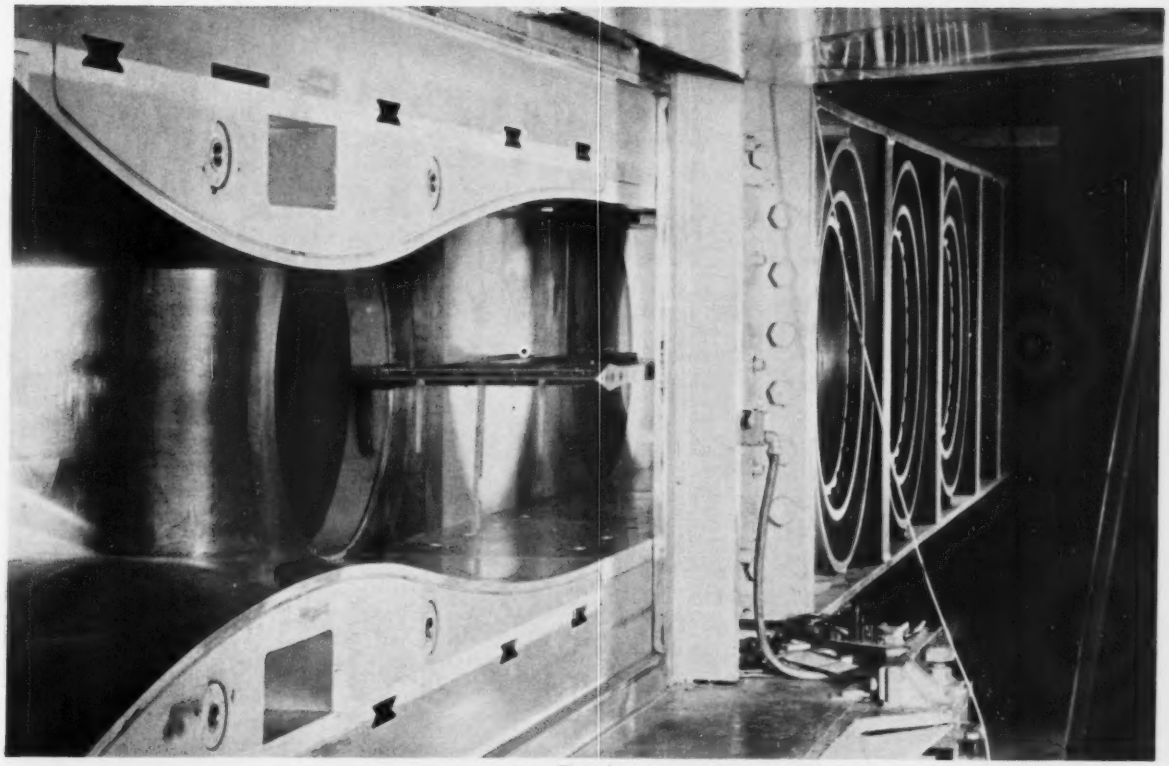


Fig. 4.
Detail view of test section showing De Laval nozzle and supersonic diffusor behind.

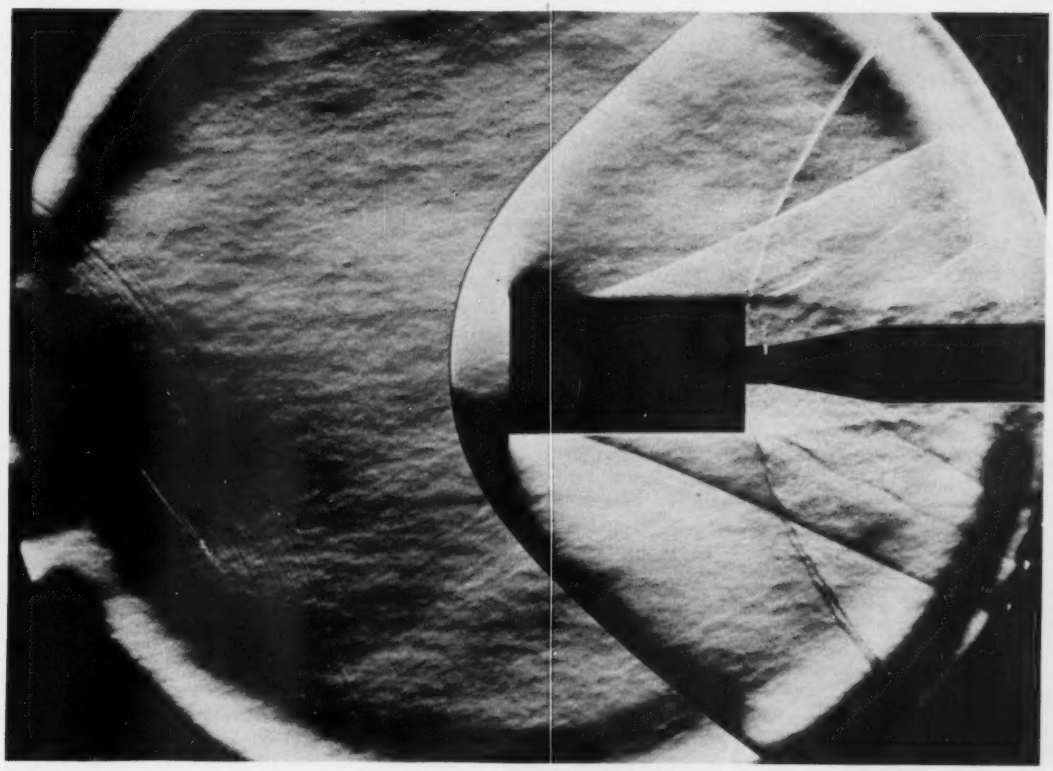
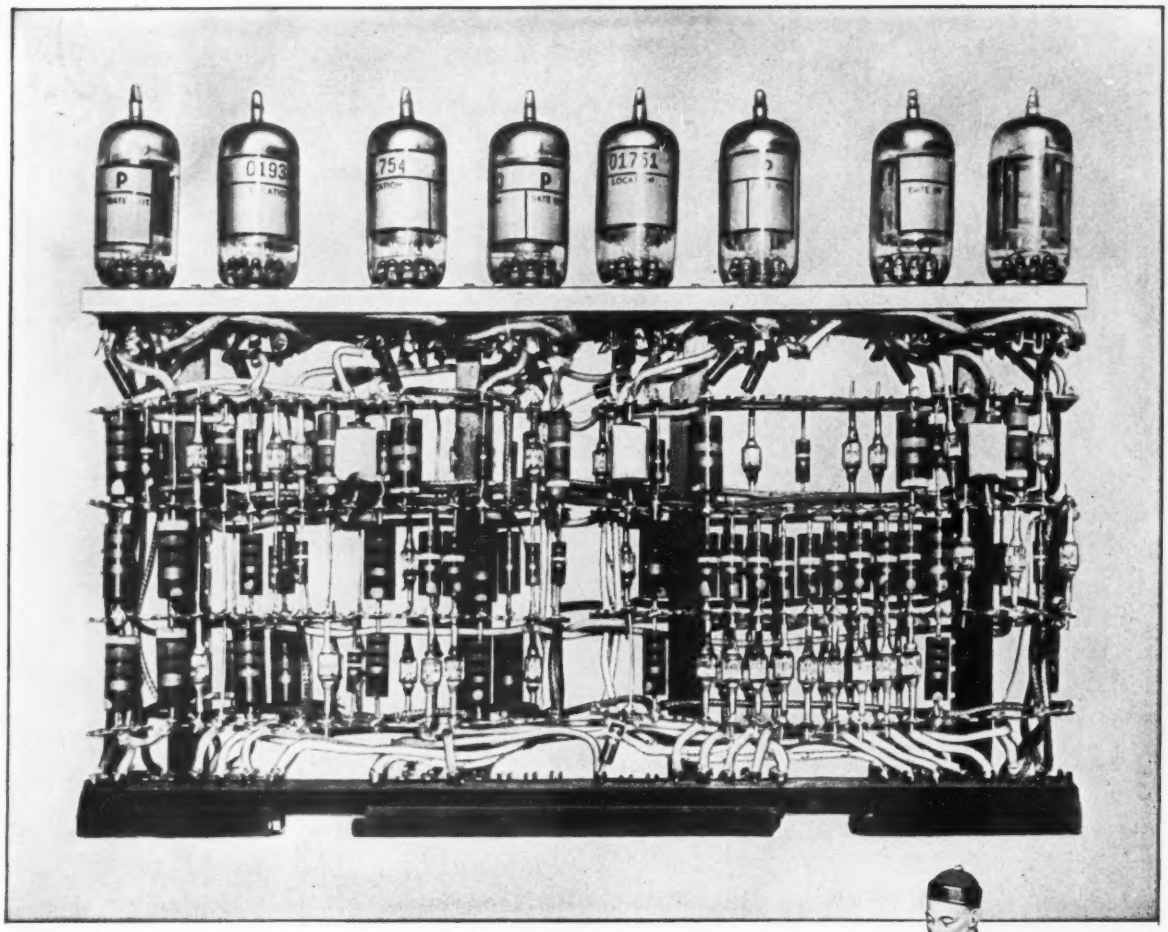


Fig. 5.

Typical photograph made with Schlieren system.



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w. m. i. t.

The Voice Of The Student

by Dave Sternlight, '54

Back in the dim and prehistoric past—about 1947 to be exact, a few upperclassmen got together and decided to attempt to start a radio station at M.I.T. The result of all this harried effort culminated in what we now know as WMIT. In several past articles, T.E.N. has kept pace with the progress of the radio station, and it is about time for another progress report on WMIT.

All residents of East Campus who have A.M. radios can now hear WMIT with high quality of reception. The Graduate House has a transmitter of its own, and residents are receiving a good signal. The Baker House transmitter is servicing this area, and under a recent grant of a loan from Dormitory Committee, WMIT is building a totally new type of transmitter to service the West Campus, and synchronize with the Graduate House

transmitter by carrying radio frequency along a co-axial type cable. It is hoped that when this transmitter is completed (sometime in 1954) the reception in West Campus will be of very high, uniform quality. So much for the transmitter end of WMIT.

Feeding the transmitters from WMIT in the basement of Ware dormitory in East Campus are six line amplifiers, built since the writing of the last article on the station. These line amplifiers take the signal to go out over the air, amplify it to such a level that it can drive the transmitters satisfactorily, and then split the signal into several isolated outputs to feed the various transmitters. These line amplifiers are driven by WMIT with its newest pride and joy, the Master Control switchbank. This device is essentially a five input, five output switch with two positions, one combination of inputs and outputs that is feeding out over the air at the moment, and another combination that can be preset for the next air shift and activated at that time by the throwing of a single switch. This activation switch can be thrown from the studio if desired. An example of the utility of this device is that at a given time the Music Library may be feeding program to the three local transmitters—East Campus, Graduate House, West Campus, and the new Infirmary transmitter. The program from the music library may also be going to Radcliffe. At five o'clock, WMIT may want to feed its local transmitters with programming from Studio A, while an audition channel is fed from Studio B, and Radcliffe continues to get the Music Library signal. This can all be set up at any time during the day, and by simply operating a switch at the proper time, the desired change will be effected automatically. To do this by the usual method of pulling patch cords would take about ten or more operations, and would take a finite amount of time, produce clicks over the air, etc., while the Switchbank accomplishes the switch instantly.

WMIT has a new Master Control room in the Ware basement, housing a new United Press teletype ticker, as well as the Swtichbank, patch fields and remote lines. WMIT is operating in a network arrangement with the Radcliffe radio station, WRRB. And since the last article on WMIT in T.E.N., it has added the programming of classical music from eleven a.m. until five p.m. from the listening room of the Charles Hayden Memorial Music Library, made technically possible by the gift to WMIT of a Collins Limiter, which replaces the studio engineer during these hours.

The remote department has been very active, bringing our listeners concerts, lectures, and special events from all over M.I.T. And most recently another LP arm has been added to the turntables in the Studio A control room, so that all LP and 78 r.p.m. records can be played on both turntables. At the moment, the station's greatest need is for a good broadcast quality tape recorder to aid in our remote broadcasts.

If any of our readers have been stimulated by this article to find out more about WMIT, it is open from five p.m. until one a.m. on weekdays, and from about nine thirty p.m. until two a.m. on Saturdays and from two p.m. to two a.m. Sundays. You are always welcome in the basement of Ware dormitory in East Campus. Why not pay us a visit?

machu pichu

The City In The Clouds

By Jon Jansen, '56

About eighty miles northwest of Cuzco, Peru, there lies a city in ruins, called Machu Pichu. This in itself is not unusual, for many remnants of the once-great Inca civilization are to be found in Peru, especially in Cuzco and vicinity. What is unusual is that such a city could have been built where this one was, and that its existence remained unknown for so long.

Machu **Pichu** is located on the top of a twin peaked mountain around which the Urubamba River makes a loop. For miles the river flows through a gorge of granite cliffs which rise almost straight up for thousands of feet. It is impossible to navigate this river, for it is but fifty yards wide and flows so swiftly and violently that anything caught in its current would be dashed to pieces against the boulders in the river and along the sides. Along the bottom of the gorge is a trail which meanders back and forth, crossing the river several times by means of rope suspension bridges. One could pass by without having the slightest suspicion that there is a city two thousand feet above him.

One might ask: why did the Incas choose such a place to build a city? It is evident that the ancestors of the Incas built most of Machu **Pichu** around 800 A.D. as a strong citadel for defense against the tribes of the plains, who were then dominant. It was very difficult and hazardous to approach even if one knew how to get there, and the people there could withstand a siege indefinitely. A few could defend it against many attackers; also, they grew their own food in terraced gardens and had an adequate water supply. As the Incas grew in numbers and strength, they conquered the tribes of the plains and moved to Cuzco, making it the capital of a vast and flourishing empire. Machu **Pichu** was abandoned and in time its existence was completely forgotten by all except the king and a few of the high priests.

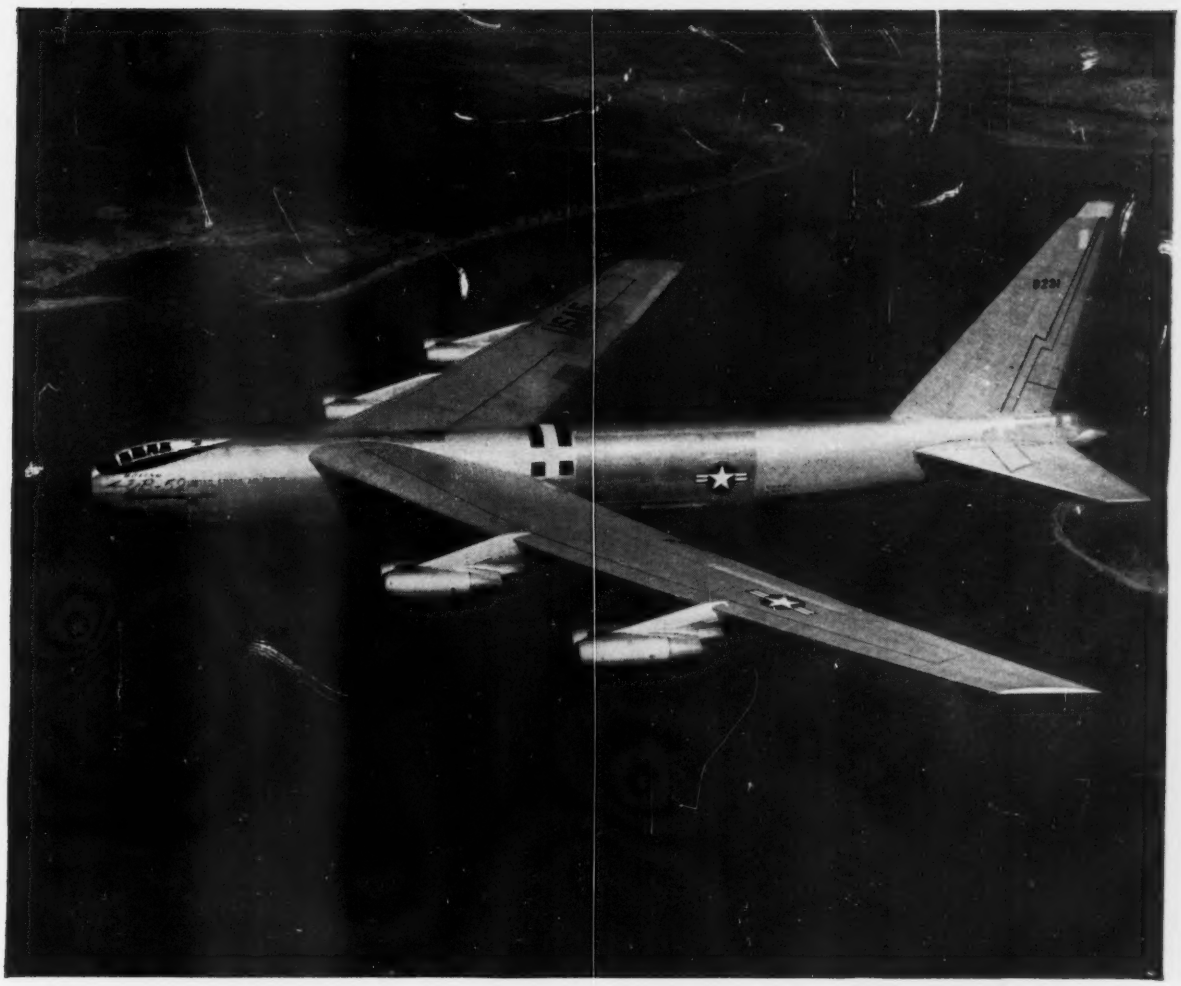
In 1534 the Spaniards under Pizarro had come and now were storming Cuzco. Atahualpa, the king, had been killed, and the empire was disintegrating. At the Temple of the Sun in Cuzco lived the Sun Virgins, who held a position in Inca society similar to that of the Vestal Virgins in ancient Rome. The Incas were determined to save them as well as what else they could of their civilization by fleeing into the nearby mountains. When the city fell, about a hundred of the Sun Virgins, the high priests, members of the royal household, and considerable treasure had disappeared. A systematic search revealed nothing of their whereabouts; they had disappeared without a trace. In the years that followed there were rumors that some Incas were living in a land called Viticas (or Uiticas) and that a new king, Manco, was holding court at Vilcabamba. Two Spanish priests had visited and described a fairly large city in the mountains but did not know how to get there. Viticas appeared on maps of Peru as late as 1746, although nobody knew where it was.

For almost four hundred years the disappearance of the last of the Incas remained a mystery. Expeditions from many nations went into the mountains of Peru looking for Inca ruins. The local natives seemed to know nothing of places fitting the descriptions of the Spanish priests, and the information they gave was based largely on folklore and hearsay, at best rather vague. In 1911, Dr. Hiram Bingham led an expedition sponsored by Yale, up the gorge of the Urubamba, where several other explorers had gone before him. A native whom he had questioned said he had heard of a ruined city farther up the river, a city in the clouds. Dr. Bingham was not sure whether to go on or not; the story seemed a bit far-fetched, and several ruins had already been discovered in that area. Maybe this was one of them; and maybe not.

Three days later the party reached a bend in the river where a peak distinguished itself from the wall of the gorge. Might not a city in the clouds be on top of a mountain such as this one? Dr. Bingham decided to climb it. At the top, nestled between two peaks was a city grown over by the jungle. After the foliage was cleared away, they discovered gold idols and other articles of religious significance. But the most amazing discovery was in a tomb. They found a hundred and thirty-five skeletons. A hundred and nine of these were women. Evidently these women were persons of great importance, for they were buried with a large quantity of gold emblems and other artifacts. Later investigations produced substantial evidence that these were the Sun Virgins who had fled Cuzco during the conquest.

In the city were found some of the finest examples of Inca masonry. The walls of these buildings were made of huge granite blocks fitted together carefully without the use of mortar. Using simple copper hand toools and lacking even the simplest of precision instruments, they hewed and finished the blocks of granite so carefully that when fitted in place one cannot wedge the blade of a penknife into the cracks between them. Such work took time, patience, and an abundance of labor. The Incas had all these. Hundreds of laborers would work years to complete buildings such as these.

Since the time of Dr. Bingham's visit, the path up the Urubamba gorge has been widened, and settlers have moved into the mountains. Today Machu **Pichu** stands for all to come and see as one of the wonders of early American civilization.



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Aircraft development is such an integral part of our national life that young graduates can enter it with full expectation of a rewarding, long-term career. Boeing, now in its 37th year of operation, employs more engineers today than even at the peak of World War II. Its projects include guided missiles, research on supersonic flight and nuclear power for aircraft.

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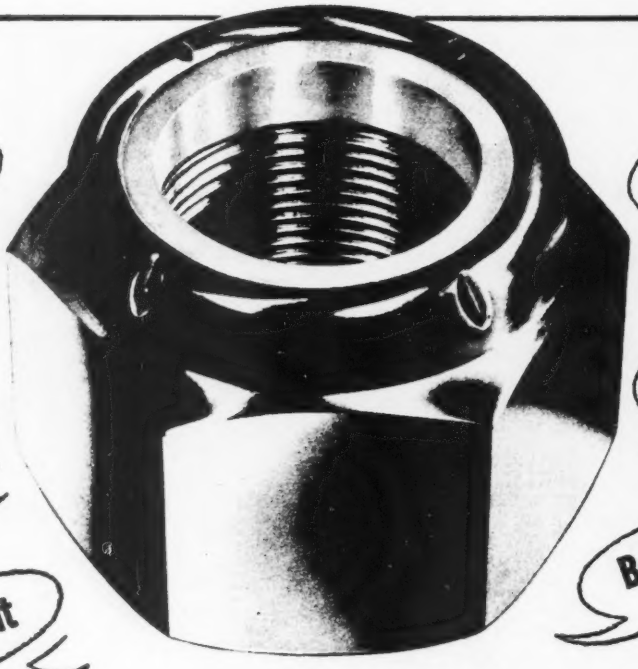

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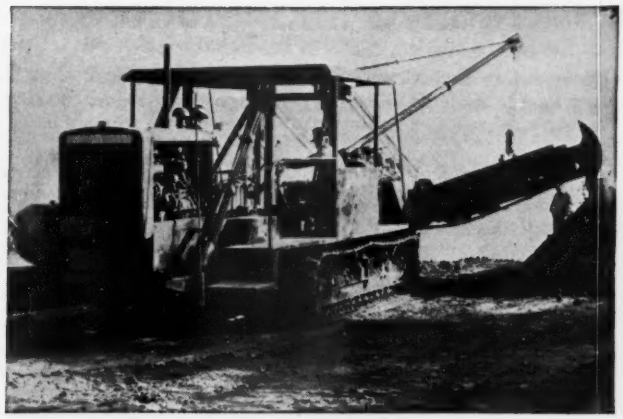

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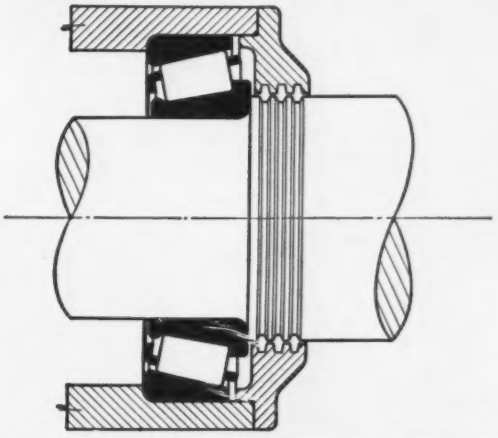

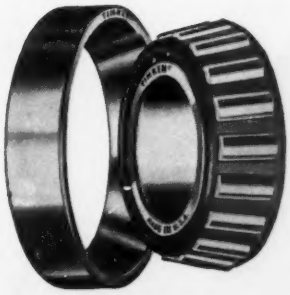

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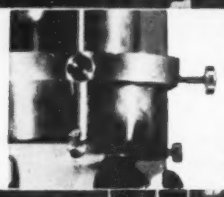
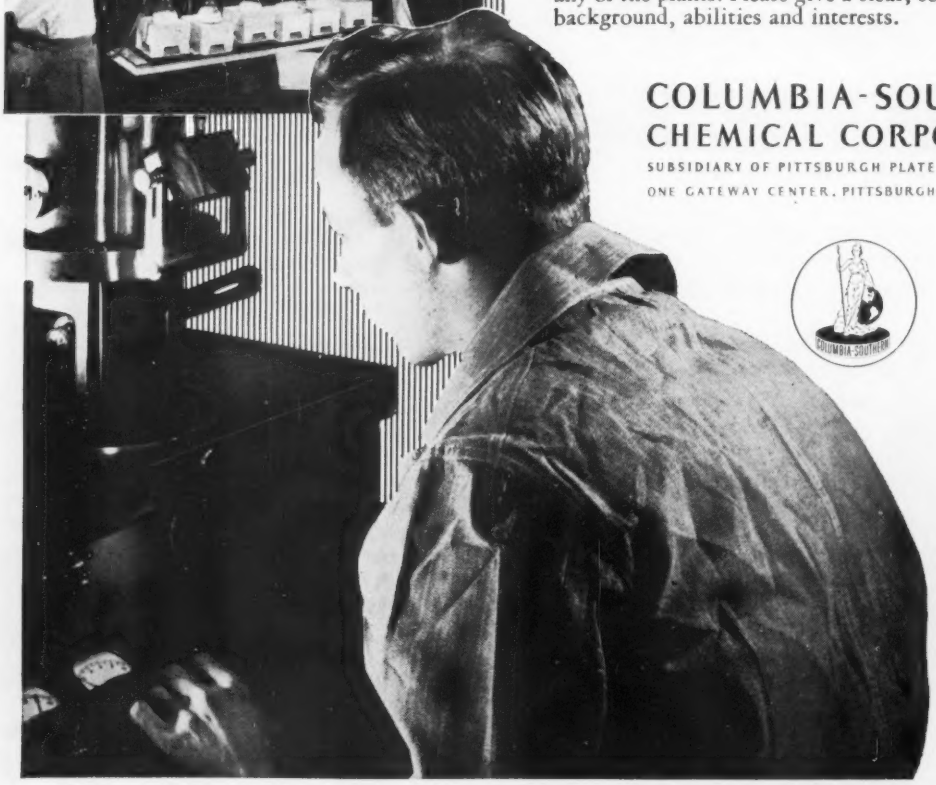


Making an analysis with the infra-red Spectrophotometer.

Testing action of Perchlorethylene on various metals.



Focusing the Electron Microscope on a chemical sample to be photographed.

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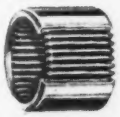
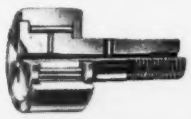
The Torrington Needle Bearing... many types for many needs

In previous advertisements in this series, the many advantages of the Torrington Needle Bearing and the proper procedure for its installation and maintenance have been discussed. The DC unit type bearing was used in these discussions because it is the Needle Bearing with by far the greatest variety of applications throughout industry.

From the basic Needle Bearing design, however, many modifications have been made. The result is a complete line of Needle Bearings suitable for specific applications. Although these bearings are all different, each offers the advantages which have made the DC unit type so popular. They give the highest possible radial load capacity in a minimum of space; they are light in weight, easy to install and simple to lubricate.

The following chart shows many types of Torrington Needle Bearings, gives their design features and general applications for which they are designed.

The new Torrington Needle Bearing catalog will be sent on request.

TYPE	SERIES	BEARINGS	DESIGN FEATURES	APPLICATIONS
DC	B		Thin, drawn shell, retaining full complement of small diameter rollers. Inner races are furnished when shafts are not hardened.	Wherever high load capacity is needed and space is at a premium.
HEAVY DUTY			The outer race is made in one channel-shaped piece, hardened and ground to precision limits. Heavy inner race.	For heavy-duty applications where split housings occur or where press fit of bearing into housing is not possible.
AIR-CRAFT	NBC		Heavy inner and outer races, with end washers securely fastened to inner race.	Aircraft applications involving oscillating motion only.
	NBE *(left)* NBK *(right)*		Similar to NBC except have self-aligning outer races.	Aircraft applications where alignment is difficult or deflection is severe.
	NBF *(left)* NBL *(right)*		Similar to NBC except have heavy outer races to carry rolling loads.	For use as rollers under heavy loads at low speeds.
CR	CR		Heavy solid-sectioned outer race and rollers made from high-quality bearing steel. Portion of stud which serves as inner race is hardened. Threaded end left soft to avoid brittleness.	Cam follower applications where maximum load capacity and shock resistance are required.

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briefing the news

National Science Foundation Fellowships

The National Science Foundation has recently announced that it plans to award approximately 750 graduate and post-doctoral fellowships for study in the sciences for the 1954-1955 academic year. These fellowships which are open only to citizens of the United States will be awarded solely on the basis of ability. They are offered in the mathematical, physical, medical, biological and engineering sciences, including physical anthoropology, psychology (excluding clinical psychology), physical geography and interdisciplinary fields.

Students studying for either their masters' or doctoral degrees are eligible for graduate fellowships at the first year, intermediate or terminal year levels of graduate study. College seniors majoring in the sciences and who expect to receive a baccalaureate degree during the 1953-1954 academic year are encouraged to apply for the awards. Individuals who have received a doctoral degree or who can produce evidence of training in a field of science equivalent to the training represented by a doctoral degree in science are eligible to apply for a postdoctoral fellowship.

The selection of predoctoral Fellows will be based on test scores of scientific aptitude and achievement, academic records, and recommendations regarding each candidate's abilities. Postdoctoral applicants will not be required to take the examinations. The evaluation of each candidate's qualifications will be made by panels of scientists chosen by the National Academy of Sciences. The final selection of Fellows will be made by the National Science Foundation.

The annual stipends for predoctoral Fellows range from $1400 to $1800; the stipend for postdoctoral Fellows is $3400. In addition to providing limited allowances for dependents and travel, tuition and certain required fees will be paid by the Foundation. The tenure of a fellowship is for one year and can be arranged to begin at any time after June 1, 1954, but normally must not be later than the beginning of the 1954-1955 academic year at the institution of the Fellow's choice.

In order to be considered for the 1954-1955 academic year, postdoctoral applications must be received in the Fellowship Office of the National Research Council by December 15, 1953 and graduate applications by January 4, 1954.

Detailed information and application forms may be secured from the Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C.

Pint-sized Atom Pile

A pint-sized atomic pile, "little brother" to the big ones used to make plutonium for atomic bombs, has been placed in operation as a research tool at the Knolls Atomic Power Laboratory, Schenectady, N. Y.

The new low-power nuclear reactor, in contrast to huge reactors at the Hanford Works, Richland, Wash., is contained in a cube of graphite measuring only five feet on a side. As such, it appears not much larger than a bank of four ordinary, office filing cabinets.

While a low-energy reactor of this sort cannot be used for making plutonium, or for the production of atomic power, it is a useful source which can be utilized in many fields of fundamental research.

A unique feature of the reactor is an internal thermal column, where the neutron flux is much greater than in the fuel region surrounding it. Fundamental properties of the various kinds of atoms which are placed in this column can be quickly and easily determined. This facility can be used to detect minute amounts of many elements, quantities considerably below the capabilities of ordinary methods of analytical chemistry. At comparably low reactor power levels, it can also make small quantities of radioactive forms of elements that are ordinarily non-radioactive. Such radioactive isotopes are finding wide use in biological and other scientific research.

The device, called a thermal test reactor, consists fundamentally of a cube about five feet on a side, made of blocks of graphite, with the atomic fuel in an 18-inch aluminum tank inside a cylindrical hole in the center of the graphite.

The fuel consists of "enriched" uranium, in which the amount of U235 has been increased. Because of its enrichment only about six pounds of such fuel are required.

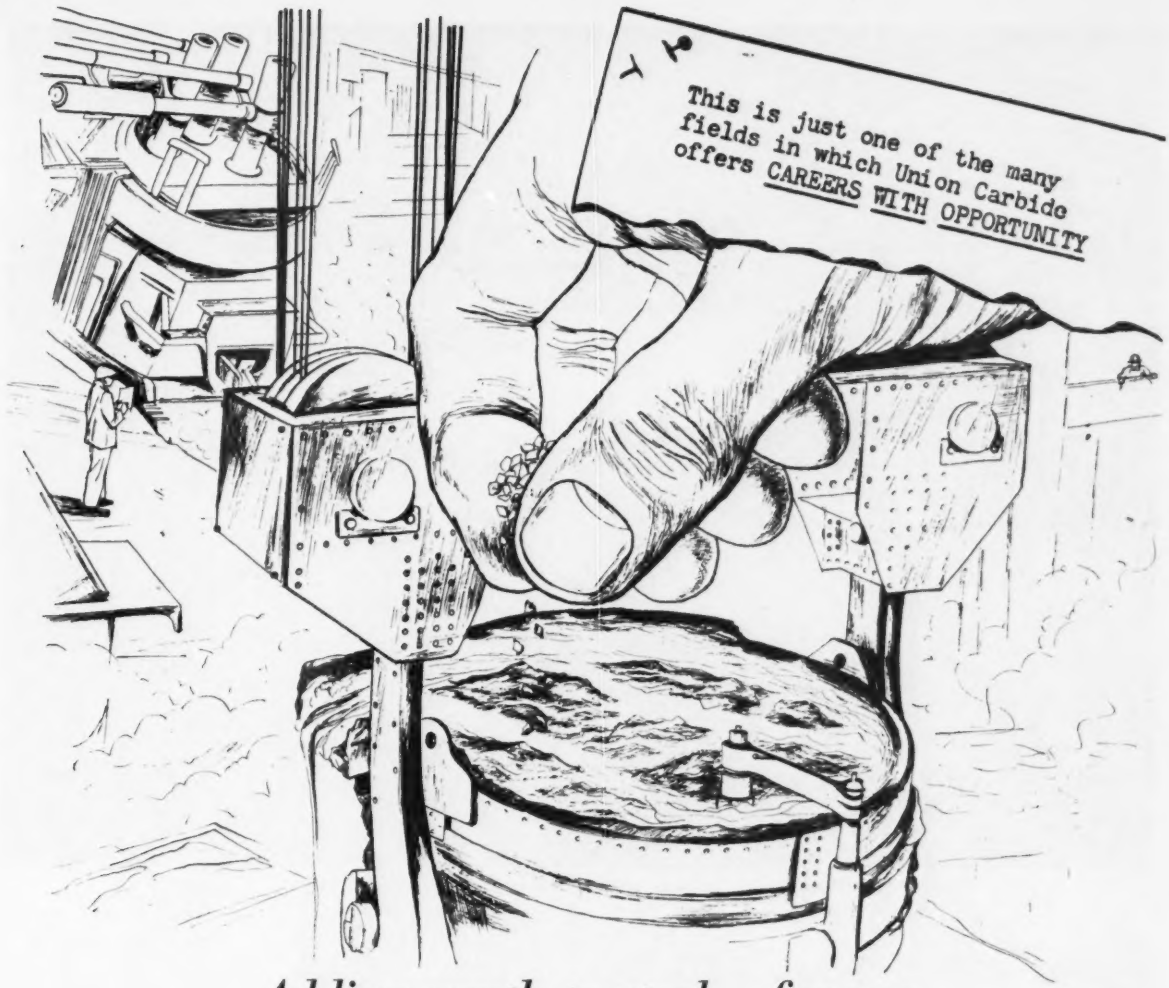
In the operation of such a reactor, the uranium 235 atomic nuclei split into two parts, by the process called fission, and as they do so neutrons are given off at high speed. Passing through the graphite, which serves as a *moderator*, they are slowed to *thermal* speeds, about the same as those of ordinary oxygen and nitrogen atoms in the air of a room. Such speeds, however, average more than a mile per second. Some of these thermal neutrons, hitting the uranium fuel elements, cause fission of more U235 nuclei and thus the chain reaction is maintained.

Project Tinkertoy

An automatic production line for the manufacture of electronic products and a novel system of electronics design which makes this possible have been developed by the National Bureau of Standards. The program was code-named Project Tinkertoy.

Starting from raw or semi-processed materials, machines automatically manufacture ceramic materials and adhesive carbon resistors, print conducting circuits, and mount resistors, capacitors, and other miniaturized component parts on standard uniform steatite wafers. The wafers are stacked very much like building blocks to form a

(Continued on page 54)



Adding youth to steel...for you

Just a "pinch" of vanadium helps steel to serve you better

STEEL IS LIKE PEOPLE. It, too, can become tired with too much shock and strain, or too much exertion. Fortunately for all of us, scientists have learned the secret of imparting the stamina of youth to steel.

SECRET OF YOUTH—It's done by adding small amounts of vanadium—often with other alloying metals—to the molten steel, usually as it comes from the steelmaker's furnace.

Thus, the springs of your car and other hard-working parts of automobiles, locomotives, ships, and aircraft withstand constant shock and strain.

WHAT IS VANADIUM? This special tonic for steel is one of the earth's rarer metals. Most of America's vanadium ore comes from the Colorado Plateau. After being concentrated and smelted, the refined metal is shipped to the steelmakers.

Vanadium is but one of many alloying metals that are used to improve today's steel. Just as vanadium makes steel shock-resistant and enduring, chromium makes it rust-resistant, tungsten makes it strong at high temperatures, manganese makes it tough at low temperatures, and silicon gives it important electrical properties.

UCC AND ALLOYS—The people of Union Carbide produce more than fifty different kinds of alloying metals, in hundreds of varying compositions and sizes. They also work closely with steelmakers in developing and improving the alloy steels that go into nearly everything that serves us today.

STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Ask for booklet F-2.*

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UCC's Trade-marked Products of Alloys, Carbons, Chemicals, Gases, and Plastics include

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Simple enough now, this vertical ascent was history-making in 1939.

You can remember
THE FIRST SUCCESSFUL HELICOPTER

Just two years *before* Pearl Harbor, Igor Sikorsky took the controls of a weird-looking machine — culmination of a dream of thirty years. Moments later it rose from the ground. Though the flight lasted only a few seconds, the VS-300 became the first practical helicopter in the United States.

Less than six months *after* Pearl Harbor, the Air Force took delivery of the first military Sikorsky.

Since then, rapid developments prove that the helicopter, most versatile of military aircraft, has tremendous commercial potentials.

Helicopters of the future will be the product of tomorrow's engineers. Sikorsky is young and growing. It offers life-time opportunities to young men who choose work where their skills and abilities will be constantly challenged.

Perhaps *you* belong at Sikorsky — in the research departments, the drafting rooms, the engineering laboratories.

You can *remember* the first successful helicopter — you may be the man to *build* tomorrow's! Learn more about employment opportunities at Sikorsky from C. R. Banks, Personnel Department.

SIKORSKY

One of the four divisions of United Aircraft Corporation **South Avenue** **Bridgeport 1, Conn.**

To many people, Grinnell is known best as a producer of high quality malleable and cast iron pipe fittings or perhaps as the manufacturer of Grinnell Automatic Sprinkler Systems. But there are other reasons behind Grinnell's leadership in the piping field. For example . . .

Grinnell makes **PIPE HANGERS** and **SUPPORTS** of all types . . . from the simplest hanger for domestic service to engineered hangers which provide flexible but constant support for piping at such temperatures as 1000°F.

Grinnell manufactures special **VALVES,** including **DIAPHRAGM VALVES** . . . designed to handle corrosive fluids, gases, beverages, foods, compressed air, suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

Grinnell **WELDING FITTINGS** and **FLANGES** are available in many different metals.

Grinnell, in short, offers industry a *full line* of piping supplies — including pipe, valves, fittings, hangers and other piping products. **GRINNELL** is an experienced well-rounded team of piping specialists, backed by highest quality products.

GRINNELL WHENEVER PIPING IS INVOLVED

Grinnell runs a six-months training course at Providence, R. I. to acquaint engineering college graduates with modern piping engineering practice and products and with Grinnell Company operations. If you are a graduating or a graduate engineer, the Grinnell training course offers you an exceptional opportunity for a sound education in piping engineering and sales and good chances for advancement. For further information, write directly to:— H. B. Cross, Executive Secretary, Grinnell Company, Inc., Providence, Rhode Island.

briefing the news

(Continued from page 50)

module is a standardized, interchangeable subassembly combining all of the requirements of an electronic circuit with ruggedness, reliability, and extreme compactness.

Project Tinkertoy was begun by NBS in May 1950 and now successfully produces electronic subassemblies by mechanized means. The pilot plant is operated by a commercial contractor as part of a large-scale production evaluation program. The basic objective in establishing the program was the development of facilities or systems suitable for rapid mobilization in emergency periods. The facilities are also dual-purposed in nature and are expected to substantially reduce lead time in production.

The key to the automatic, mechanized production of electronic equipment in Project Tinkertoy is the design system developed by the National Bureau of Standards. Called MDE—for Modular Design of Electronics—the system establishes a series of mechanically standardized and uniform modules (or building blocks), producible with a wide range of electrical characteristics.

Each module, in general, consists of some 4 to 6 thin ceramic wafers, bearing various circuits associated with an electronic stage. A number of individual modules are combined to form a major subassembly. The composition of modules into major subassemblies of electronic equipment is possible because there is great similarity between circuits and parts of circuits in modern electronic equipment.

Electronic assemblies consist largely of electronic tubes and arrays of simple parts (like resistors and capacitors) which account for the mass of the individual parts and are also responsible for the bulk of the manual production efforts in conventional production. These assemblies have been the chief target for redesign in the MDE system.

The production of modules and assemblies, designed in accordance with the MDE system, is achieved mechanically in Project Tinkertoy. The production system developed by the National Bureau of Standards is called MPE—Mechanized Production of Electronics. MPE largely utilizes non-critical raw materials. Ceramic wafers—$\frac{7}{8}$ inch square by 1/16 inch thick—are produced directly in quantity from the raw ingredients. Ceramic capacitors are produced in a similar fashion. Another part of the line produces adhesive tape resistors.

These and other basic parts are fed into the production line. The appropriate circuits are printed by automatic machines. The circuit configuration is achieved through photographic processing. Quality control is established by automatic inspection, directed by information prepared in punched card form. Special components, not suitable for "printing" techniques, can be incorporated into the modules. Automatic physical and electrical inspection is provided for in the production line.

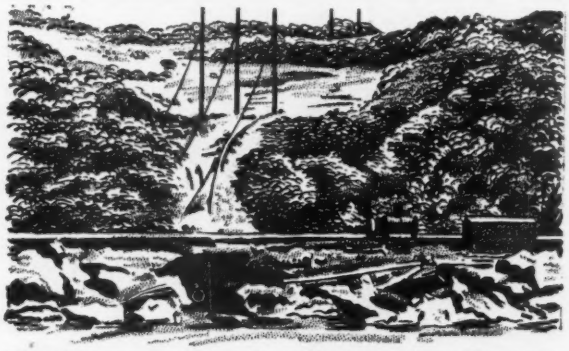
The MPE system is based on the use of bulk or semiprocessed materials, and the line produces all the large-quantity parts except for the tubes. The pilot plant is designed for a production goal of 1,000 modules per hour. Joining modules together to form subassemblies may also be accomplished by machines.

Project Tinkertoy was sponsored by the Industrial Planning Division of the Navy Bureau of Aeronautics as an industrial preparedness measure. One of the serious bottlenecks in emergency periods has turned out to be the production of electronic equipment, upon which the military services are increasingly dependent for success in modern defense. Project Tinkertoy indicates that lead time in production can be reduced 75 percent.

Magnetic Drum Calculator

International Business Machines Corp. has announced the introduction of a new commercial electronic decimal calculator designed to meet the vast accounting and computing requirements in areas between those now served by its "giant brains" and the widely-used smaller machines. Called the Magnetic Drum Calculator, the new machine combines one of the advanced memory devices and the stored program concept, with new high speed reading capacity in the conventional punched card equipment to achieve a powerful data processing machine for commercial and engineering requirements.

(Continued on page 56)



The first submarine installation of a pipe-type cable system **was recently installed under the Hudson River at Poughkeepsie, N.Y. Three cables, each nearly ¾-miles long, were simultaneously pulled into a six-inch welded steel pipe laid across the river bottom. The pipe was then filled with oil maintained at 200 lbs. pressure, enabling a 110,000-volt power circuit to cross the river safely.**

This kind of system is called Oilostatic—a design which has long been first choice among utilities for handling large blocks of power by means of a high-pressure pipe-type cable system. Increased circuit reliability and savings on installation and maintenance costs are realized.

Oilostatic's new role as a submarine cable is typical of the significant contributions to better electrical service made by Okonite engineers.

● ● ●

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE ***insulated wires and cables***

8750

Owner goes 'round the world in 40 seconds!

With this new multi-wave portable you can circle the globe in the time it takes to twist a dial.

That's because the RCA Victor Strato-World radio has Electronic Band Spread Tuning.

Instead of being squeezed together on one band segment, short-wave stations are in spread formation across the dial of your 7-band Strato-World. You tune London, Rome, Moscow, Tokyo just like local stations.

There's real *one-handed* portability, too. The Strato-World is a trim 23 pounds, with batteries . . . or it can be plugged into an electrical outlet. Smartly styled, with genuine cowhide case!

Here is the performance, the engineering and design you've come to expect from RCA Victor, a division of the Radio Corporation of America. See this globe-trotting, pace-setting portable at your RCA Victor dealer's.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA ® *RADIO CORPORATION OF AMERICA*

World leader in radio—first in television

HOW TO CREATE SUCCESSFUL DESIGNS

SIMPLY being able to create a unique machine design is no longer enough to insure a successful career in product engineering. Today, more than ever before, a machine design must be strong and durable, *yet be the lowest in cost,* to be acceptable to company management.

As a result, many new designs are of welded steel construction and existing designs are being converted to eliminate excessive material and to reduce the number of shop manhours needed for fabrication.

Fig. 1. Former Design. *Machine part required milling and drilling. Weighed 18 pounds, twice as much as steel design.*

Fig. 2. Present Construction. *Bearing Housing and arms are 10 gauge metal. Weighs only 8½ pounds. Cost 30% less to manufacture.*

HOW TO DESIGN FOR WELDED STEEL

As a result of such economies, it is important that forward-thinking engineers maintain close contact with the rapid progress in the arc welding industry. Latest data on design for welded steel construction is available in bulletins and handbooks. Write to The Lincoln Electric Co., Cleveland 17, Ohio.

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Proof from The Griswold-Eshleman Co., Cleveland Engineering College Magazines—November, 1953 Ad No. E-994

briefing the news

(Continued from page 54)

In addition to its usefulness as an accounting and computing tool, the Magnetic Drum Calculator will be a vital factor in familiarizing business and industry with the stored program principles fundamental to electronic data processing equipment. Though its capacity is large, it is designed for exceptional ease of problem preparation and operation. A significant feature of this machine is its ability to check the accuracy of its answers.

Typical application of the Magnetic Drum Calculator is the simultaneous computation of insurance premiums and calculation of required reserves. For the automobile industry, the calculator can "remember" several weeks' or months' production schedule of finished products, and at the same time calculate at high speed the number of parts required for their production. It can take into account such factors as "lead time" and indicate the dates on which orders must be placed for each part to be available for scheduled assembly.

Because of such advanced techniques as its large stored program and its extensive memory capacity, the drum calculator can incorporate in one machine operations in punched card accounting which once required several machines. A numeric decimal machine, it has up to 20,000 memory positions and can accept as many as 2,000 individual operating instructions to facilitate commercial and scientific computations. It consists of three units: a magnetic drum unit with electronic calculating components, an input and output unit, and a converter. It occupies approximately the same area as two ordinary office desks and a filing cabinet.

All of the calculator's arithmetic operations are controlled through a program which may be entered either automatically from punched cards or manually from the operator's console and stored in the form of magnetized spots on the surface of a drum only 4" in diameter and 12" long, spinning at 13,000 revolutions a minute. The calculator's arithmetic unit operates at electronic speeds. It can: accumulate 10 digit numbers to form a 20 digit total at the rate of 200 a second; multiply 10 digit numbers by 10 digit numbers to develop a 20 digit product at the rate of 100 a second, and divide a 19 digit number by a 10 digit divisor to develop a 10 digit quotient and a 10 digit remainder at the rate of 80 a second. It has an input rate of 200 punched cards a minute and a separate output of 100 cards a minute. In addition to its large numerical capacity, the calculator also features a "Table Look-up" operation which facilitates the automatic searching of rate tables such as occur in the utilities, life and casualty insurance, transportation and other commercial fields.

Robot Psychologist

A "robot psychologist" with an electronic brain, memory, and "show window" viewing screen is helping human psychologists see that the right man gets the right Army job.

Described as so complex that only skilled psychologists can operate it and understand results, the machine was in planning and consideration for three years at the Army Personnel Research Branch and an additional two years in research and development at the G-E laboratory.

Psychological problems are first translated into statistical form and then fed into the giant computer. A maze of vacuum tubes, potentiometers, wires and other electrical apparatus literally hums through the data and flashes results on a cathode ray tube, similar in appearance to a 16-inch television viewing screen. The operating psychologist sees the test results in the form of "scatter diagrams" or dot patterns. Data not required during a particular problem are stored in the machine's electronic "memory" for future use.

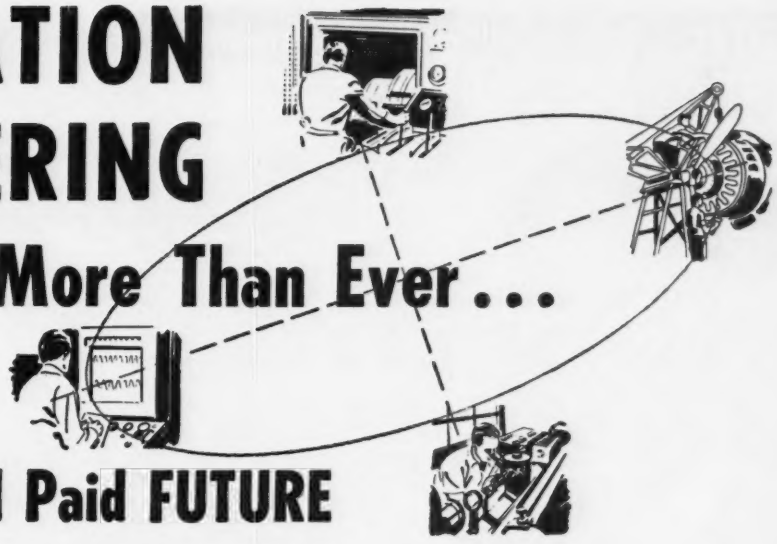
The time required for solving complex problems can be reduced from months or even years to a matter of days through use of the new computer.

AVIATION ENGINEERING

Today More Than Ever . . .

Offers

A Sound, Well Paid FUTURE



Today's graduate engineer seeking a secure, well paid career will do well to look to the aviation industry, provided he joins a *leader* with *permanent roots* in the field.

Such a company is Curtiss-Wright, and here is why it will continue to provide exceptional engineering career opportunities of many kinds:

Aviation is a precision industry in which new developments are rapid and continuous. Curtiss-Wright, always in the forefront of these advancements, is a center of research programs that go beyond aviation itself and thus create new products and processes affecting many *other industries* as well. The company's leadership in military aviation power is assured by long range procurement plans. Civilian production is growing, in both aviation and developments in other industries.

To meet aviation's need for ever-better materials and techniques, Curtiss-Wright explores many fields – hydraulics, mechanics, electronics, plastics and metallurgy . . . new alloys and casting methods. Out of this research come not only improved propellers and powerplants, but many things with applications in general industry.

So great an asset is this pool of engineering experience that the nation's government and economy could ill afford to be without it under any foreseeable circumstances.

For these reasons, including the wide range of projects at Curtiss-Wright, the company offers stability and solid career jobs for qualified engineers. One may choose his favorite field or specialty and look for increasing advancements and rewards as fast as he can assume responsibility.

WRIGHT AERONAUTICAL DIVISION centers around development and production of reciprocating and jet engines, and development of turbojets and ramjets.

PROPELLER DIVISION is far broader than the name implies. In addition to propeller research and production, it embraces machine design, stress analysis, aerodynamics, hydraulics, metallurgy, electronics, servomechanisms, instrumentation and controls.

Jobs are waiting for those engineers:

AERONAUTICAL • METALLURGICAL • ELECTRICAL
MECHANICAL • ENGINEERING MECHANICS MAJORS

If you want permanence, progress and good pay that grows better, living near your work in a desirable home area, arrange with your placement office for an interview with our representatives when they visit your campus.

CURTISS-WRIGHT CORPORATION • WOOD-RIDGE, N. J.

"I chose Worthington for opportunities in international trade"

• "Worthington was my choice," Mr. Berger says, "because of the excellent training and the unusual experiences that are possible with a manufacturer having a worldwide reputation, and worldwide distribution. Then, when a company has seventeen divisions, including air conditioning, refrigeration, turbines, Diesel engines, compressors and pumps of all kinds, construction machinery, and power transmission equipment, a graduate engineer's chances for getting into his chosen field are even better.

"Supporting these divisions are research, engineering, production, purchasing, and sales, domestic and export. The real opportunity, however, is in Worthington itself. This is a company that is growing, just as it has for more than a century. It is always looking for new, related products and good men to engineer, produce, and sell them—at home and abroad.

"I began my career with Worthington's training program in the Research and Development Laboratory, where full-scale equipment is designed, tested and improved. This experience gave me an understanding of the tremendous part the company plays in the everyday life of millions of people. Within fourteen months I was sent to Mexico to inspect the facilities of our distributors there.

"The opportunities for first-hand laboratory experience, sales training and contact, travel and field trips, among many others, make Worthington a first-rate company for the young engineer with a desire to learn and progress in his work."

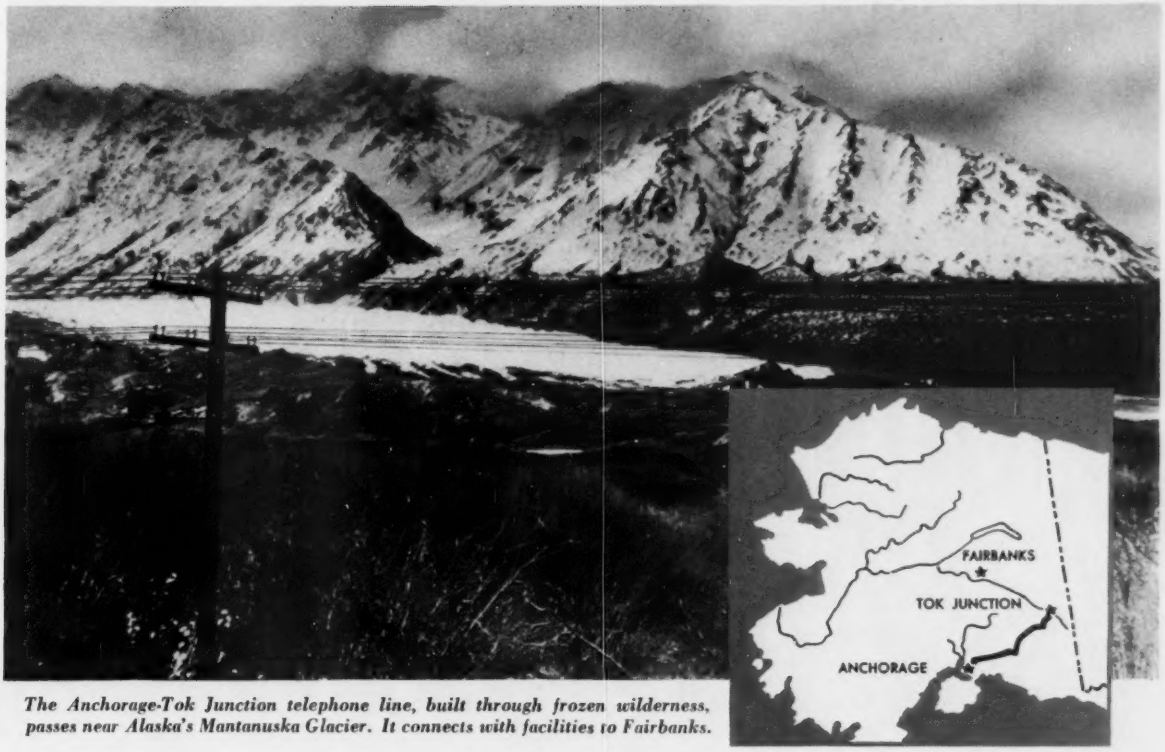
When you're thinking of a good job, think *high*—think *Worthington.*

3.26

FOR ADDITIONAL INFORMATION, see your College Placement Bureau, or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

WORTHINGTON

THE SIGN OF VALUE AROUND THE WORLD



The Anchorage-Tok Junction telephone line, built through frozen wilderness, passes near Alaska's Mantanuska Glacier. It connects with facilities to Fairbanks.

The line is through to Tok Junction, Alaska

Ever hear of permafrost? It's sub-surface earth, permanently frozen hard as rock. But it was only one small problem in pushing through Alaska's newest telephone line

As the nation's defense perimeter was pushed northward, it became plain that high-speed communications were needed for Alaska. The Army Signal Corps asked the Bell System to help build a modern telephone line for our strategic northern outpost. Today the line is a fact.

But the 330-mile route between Anchorage and Tok Junction on the Alcan Highway called for all the resourcefulness and skill of Bell System and Army engineers.

What type of line? Engineering studies and surveys proved that weather, expense and maintenance problems made it impractical for the new line to be aerial or buried cable or radio relay. The answer was open-wire pole line plus carrier equipment. But stringing this line through frozen wilderness was rough business.

The line had to cross two high mountain ranges. Average spacing between poles was 155 feet, but to bridge rivers, ravines and steep mountainside descents called for long-span crossings, ranging from 400 to 1800 feet.

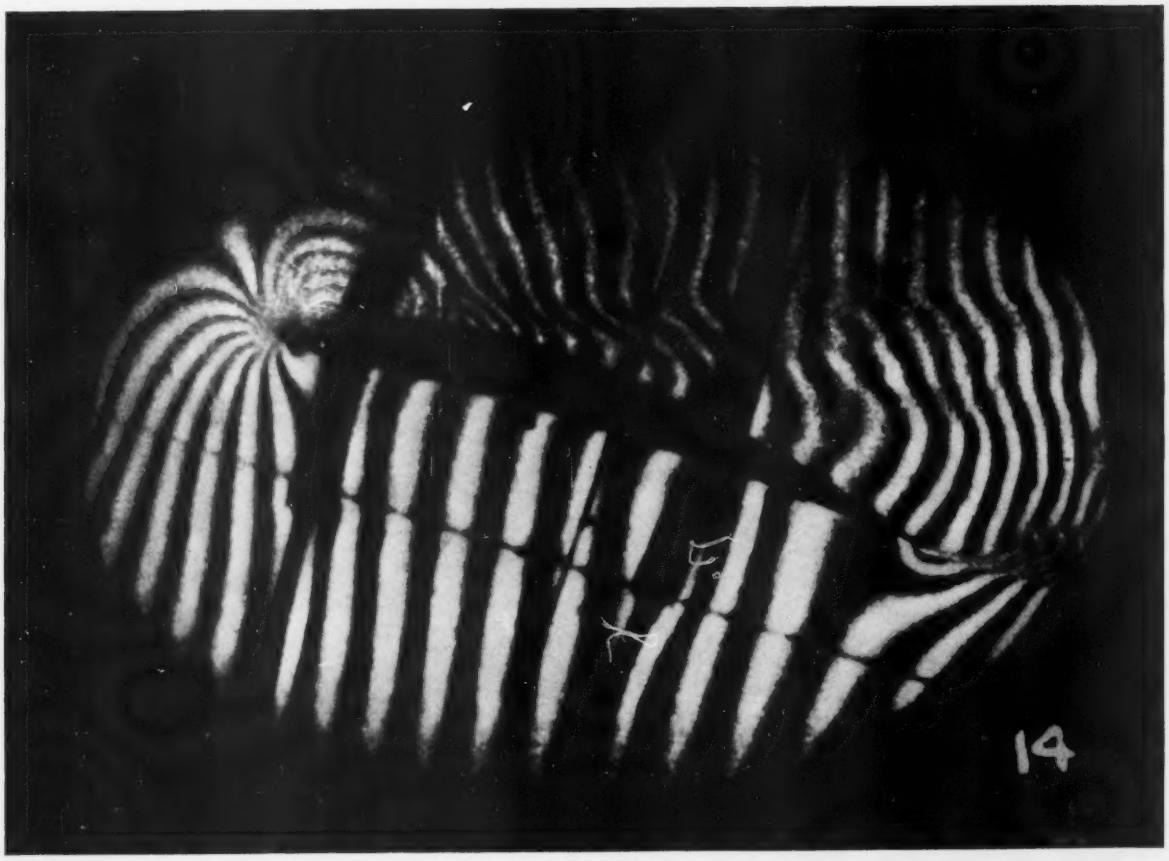
Getting the right vehicles, tools, and materials to the right places when needed was a major feat of planning in this wilderness. The line called for 15,000 poles of varying lengths, 2500 crossarms, 1,325,000 pounds of copper-steel wire and 2400 tons of hardware.

Dynamite licks permafrost. Bulldozers, pole-hole diggers and big trucks battled their way over tortuous mountain roads. The simple process of setting poles proved almost impossible in some areas because of a volcanic silt hardened by permafrost. No drill was tough enough to withstand its pumice-like action. The problem was licked by punching holes and using small dynamite charges.

But now the work is done. Engineers have turned their talents to other parts of the vital communication system—building a long distance dial switching system between Anchorage and Fairbanks.

And so it is with the fast-growing telephone company. There always is a new frontier to conquer—in research, at the Bell Laboratories, in manufacturing at Western Electric, or in one of the operating companies serving the changing requirements of a constantly shifting population. Check now with your Placement Officer on the opportunities which await college engineers in the Bell System.

BELL TELEPHONE SYSTEM



fingerprint of a flutter . . .

A jet engine compressor blade oscillating in a high-velocity airstream made this fingerprint-like picture. Such interferograms, taken at the rate of 5000 per second, help our engineers to visualize why blades flutter. By analysis, instantaneous vibratory forces can be measured.

Accurate knowledge of blade forces and stresses permits our engineers to design the lightest blades consistent with reliability.

Studies of flow dynamics are important. Yet this is only one small phase of the research that goes into the successful development of high-performance, dependable aircraft engines for supersonic flight.

At Pratt & Whitney Aircraft the use of advanced techniques is encouraged — the most advanced facilities made available because we know that good engineering requires good tools. This partially explains why so many outstanding engineering graduates have been attracted to a career at Pratt & Whitney Aircraft.

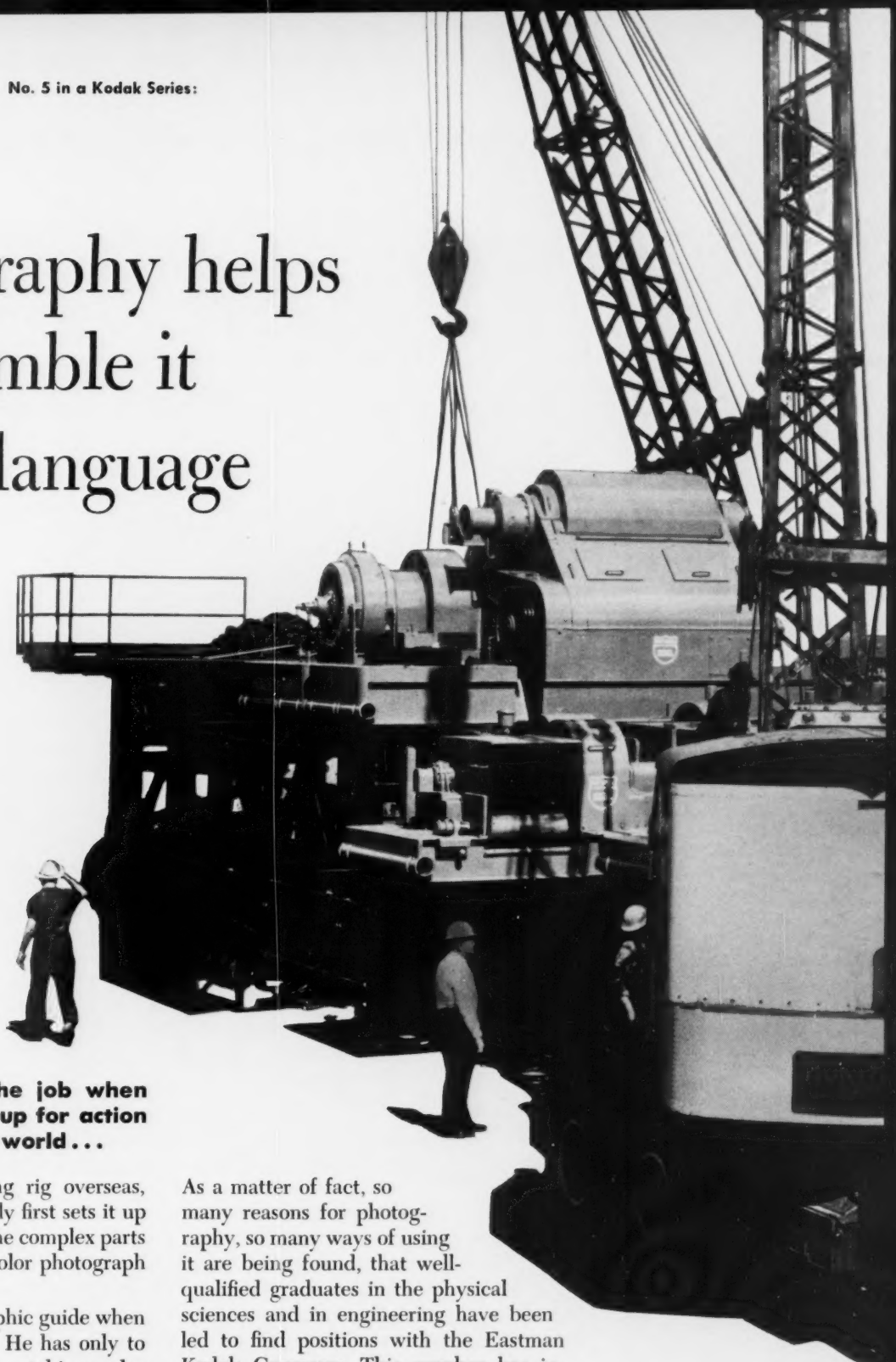
PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut

PHOTOGRAPHY AT WORK No. 5 in a Kodak Series:

Photography helps assemble it in any language



Pictures help boss the job when this drilling rig is set up for action half way around the world . . .

Before shipping a drilling rig overseas, National Supply frequently first sets it up here for tests and paints the complex parts in *coded colors*. Then a color photograph is made.

Why? To serve as a graphic guide when the rig reaches its buyer. He has only to follow the photograph—matching color to color—and the rig virtually assembles itself. As a technique, this use of photography makes unskilled labor more efficient, slices through the problem of language barriers.

National Supply's experience is an example of how photography saves time, cuts cost, reduces error, improves output.

As a matter of fact, so many reasons for photography, so many ways of using it are being found, that well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company. This number has included many returning servicemen.

* * *

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company
Rochester 4, N. Y.

Kodak
TRADE-MARK

JOHN B. NOLTE, Purdue University, asks:

"What is G.E.'s Manufacturing Training Program?"

The Manufacturing Training Program at General Electric is a program of basic training for manufacturing leadership, including planned rotational work assignments and related classroom study for outstanding young men who are interested in a career in manufacturing. It was organized to meet the increased demand for effective manufacturing leadership and technical "know how," in line with the expansion and development of the Company's operations by developing trained men to fill future key positions in the organization.

Who is eligible for this program?

In general, the Program is open to college graduates with degrees in engineering and science, and a limited number of business administration and liberal arts graduates. We are looking for outstanding young men with sound educational backgrounds, well-balanced personalities, demonstrated thinking abilities, and having the potential to develop toward top level responsibility in key assignments.

How long is the program?

The normal length of the Program is three years. However, some individuals may be able to complete their training in a shorter period because of previous knowledge or experience in manufacturing work.

What type of work assignments are made?

Work assignments are provided in all phases of manufacturing and related functions so that each man will acquire knowledge of manufacturing engineering, including manufacturing methods and techniques, shop operation, production control, personnel administration, labor relations, engineering activities, sales and manufacturing co-ordination, and general business administration.

In addition to job assignments, classroom courses cover such subjects as Company organization, manufacturing operations, labor and personnel relations, business administration, law and relationships between manufacturing and other functions of the business. Progress on the job and in classroom work is carefully observed and reviewed periodically with each man to assist him in his career.

What happens after training is completed?

After completing the training program, graduates are placed in operating departments and divisions throughout the Company in positions where leadership and initiative are needed. All placements are made in relation to the aptitudes, abilities, and interests of the graduates.

At General Electric, manufacturing operations involve the administration and supervision of activities of more than 100,000 men and women in more than 100 plants, who are involved in the making of some 200,000 different products.

The wide scope of these activities, the great variety of products, and the diversity of manufacturing activities offer limitless opportunities and exciting challenges to college graduates today.

Manufacturing training is a foundation for leadership—and an opportunity to build a satisfying, rewarding career in one of America's most important industries.

If you are a graduate engineer, or a graduate with definite technical inclinations that include an interest in the career possibilities in manufacturing, see your college placement director for the date of the next visit of the General Electric representative on your campus. Meanwhile, for further information on opportunities with General Electric write to College Editor, Dept. 2-123, General Electric Company, Schenectady 5, New York.

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